PROCEEDINGS

OF THE

BOARD OF AGRICULTURE IN INDIA

HELD AT

PUSA

CALCUTTA:

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No. C. 34, dated Camp Pusa, the 22nd January 1906.

From—F. G. Sly, Esq., I.C.S., Offg. Inspector General of Agriculture in India,

To—The Secretary to the Government of India,

Department of Revenue and Agriculture.

I have the honour to submit the Proceedings of the Second Meeting of the Board of Agriculture held at Pusa on the 15th January 1906 and succeeding days. These proceedings have been recorded by the Secretary, Dr. E. J. Butler, Cryptogamic Botanist to the Government of India, and have been approved by the Board.

Proceedings of the 2nd Annual Meeting of the Board of Agriculture held at Pusa on the 15th January 1906 and succeeding days.

List of Members.

1. F. G. Sly, I.C.S., *Officiating Inspector General of Agriculture in India, President of the Board.*
2. Dr. E. J. Butler, M.B., F.L.S., *Cryptogamic Botanist to the Government of India, Secretary to the Board.*
3. Colonel J. W. A. Morgan, M.R.C.V.S., *Inspector General, Civil Veterinary Department.*
4. B. Coventry, *Director, Agricultural Research Institute and Principal of the Agricultural College, Pusa.*
5. Dr. J. W. Leather, Ph.D., F.I.C., F.C.S., *Agricultural Chemist to the Government of India.*
6. H. M. Lefroy, M.A., F.E.S., F.Z.S., *Entomologist to the Government of India.*
7. C. J. Bergtheil, *Bacteriologist, Agricultural Research Institute, Pusa.*
8. E. Shearer, M.A., B.Sc., *Agri-Horticulturist, Agricultural Research Institute, Pusa.*
9. A. Howard, M.A., A.R.C.S., F.C.S., F.L.S., *Economic Botanist, Pusa.*
10. T. F. Main, B.Sc., *Assistant Inspector General of Agriculture in India.*
11. R. W. B. C. Wood, B.A., *Supernumerary Deputy Director of Agriculture, Pusa.*
12. Captain A. T. Gage, I.M.S., M.B., M.A., B.Sc., F.L.S., *Officiating Director of Botanical Survey of India.*
13. C. E. A. W. Oldham, I.C.S., *Officiating Director of Agriculture, Bengal.*
14. F. Smith, B.Sc., *Deputy Director of Agriculture, Bengal.*
15. Captain A. S. Trydell, M.R.C.V.S., *Superintendent, Civil Veterinary Department, Bengal.*
16. R. S. Finlow, B.Sc., F.C.S., *Jute Expert to the Government of Bengal.*
17. W. H. Moreland, B.A., LL.B., C.I.E., I.C.S., *Director of Agriculture, United Provinces of Agra and Oudh.*
18. J. M. Hayman, *Deputy Director of Agriculture, United Provinces of Agra and Oudh.*
19. H. M. Leake, M.A., F.L.S, *Economic Botanist, United Provinces of Agra and Oudh.*
20. W. C. Renouf, I.C.S., *Director of Agriculture, Punjab.*
21. S. Milligan, M.A., B.Sc., *Deputy Director of Agriculture, Punjab.*

22. H. S. LAWRENCE, I.C.S., *Director of Agriculture, Bombay.*
23. F. FLETCHER, M.A., B.Sc., *Deputy Director of Agriculture, Bombay.*
24. J. B. KNIGHT, M.Sc., *Professor of Agriculture, College of Science, Poona.*
25. G. A. GAMMIE, F.L.S., *Economic Botanist, College of Science, Poona.*
26. A. A. MEGGIT, B.Sc., *Agricultural Chemist, Department of Agriculture, Bombay.*
27. C. BENSON, M.R.A.C., *Deputy Director of Agriculture Madras.*
28. C. A. BARBER, M.A., F.L.S., *Government Botanist, Madras.*
29. L. E. P. GASKIN, I.C.S., *Director of Agriculture, Central Provinces.*
30. D. CLOUSTON, M.A., B.Sc., *Deputy Director of Agriculture, Central, Provinces.*
31. RAI BAHADUR R. S. JOSHI, L.Ag., *Assistant Director of Agriculture, Central Provinces.*
32. RAI BAHADUR B. C. BASU, M.R.A.C., *Assistant to the Director of Agriculture, Eastern Bengal and Assam.*
33. DR. H. H. MANN, D.Sc., *Scientific Officer to the Indian Tea Association.*
34. DR. A. LEHMANN, M.A., B.S.A., PH.D., *Agricultural Chemist to the Government of Mysore.*
35. RAOJIBHAI B. PATEL, M.R.A.C., *Director of Agriculture and Industries, Baroda State.*

FIRST DAY.

CONFIRMATION OF THE MINUTES OF THE LAST MEETING.

1. The Proceedings of the last meeting held on January the 6th, 1905, and succeeding days, were confirmed.

2. The President then made a short statement of the action taken during the year on the recommendations of the Board. (See Appendix I.) He mentioned that effect had been given by the Supreme Government, by Local Governments, and by the departments of agriculture to almost every recommendation of the last Board.

3. Regret was expressed that the Government of India had been unable to relax the rules in regard to the purchase of scientific stores direct from the manufacturers by the officers concerned, but it was considered that the question could not be re-opened in the absence of any new arguments in favour of relaxation.

4. It was stated by the President, in response to inquiries, that general orders regarding the question of direct correspondence between expert officers of the different departments of agriculture would shortly be issued by the Government of India.

AGRICULTURAL EDUCATION.

5. The President then initiated a discussion on some general principles connected with agricultural education, in order to allow of early reference being made to sub-committees of the Board for the purpose of drawing up a standard curriculum for agricultural colleges. He reminded the Board that their functions are advisory only, and that the very different local conditions of each province make it impossible to lay down a fixed course of study applicable to all India. He pointed out the danger of attempting to include too much in the course of studies, and suggested that the separate subjects of study should be limited as far as possible, because of the danger of attempting to teach more than the time of the course and the ability of the students would permit.

The Board decided to frame a standard curriculum, which might serve as a guide to assist provincial departments in settling their college schemes; that the standard curriculum should be drawn up for a full three years' course of education, with the object of turning out students with a general knowledge of agriculture, which would fit them for upper subordinate posts in agricultural departments, and for employment as managers of Court of Wards and private estates. It was agreed that the Board should propose a certain minimum course, which should be held as essential in all colleges, but which should allow of a margin for expansion or modification to meet special local conditions.

In regard to the standard of educational qualifications which should admit of entry to agricultural colleges, the Board is of opinion that the minimum qualification should be that required for the Entrance, Matriculation, or some examination of equal standing, except in the case of private students who may not have in view employment in Government service, and who may be admitted on the Principal of the college satisfying himself that the general education of the student is sufficient to enable him to benefit fully by the instruction provided, even though he may not have passed any public examination. A good knowledge of English is held to be essential for all students.

The Board is of opinion that the course should be sub-divided for the purposes of drawing up a curriculum into the following main sections :—

(1) agriculture, including geology and the study of soils;
(2) chemistry and physics;
(3) biology, including animal physiology and entomology;
(4) other and minor subjects, including surveying, mensuration, elementary engineering, veterinary science, meteorology and the like.

The working hours may conveniently be assumed to be thirty-three a week, divided into five days of six working hours and a half day of three hours on Saturday. Taking the working year at about eight months, this provides for a total of eleven hundred hours a year, and it is proposed to allot this for the purposes of framing a curriculum as follows :—agriculture 35 per cent. of the total working hours, chemistry and physics 25 per cent., biology 25 per cent., and minor subjects 15 per cent.

The Board further recognises, as a general principle in agricultural education of the sort contemplated, that the purely scientific teaching which is required should, as far as possible, be provided at an early period in the course, so as to permit of the later stages being held free for the application of these sciences to practical agriculture.

The following sub-committees were nominated :—

(1) *Agriculture.*—Messrs. Moreland, Benson, etcher, Clouston and Hayman.
(2) *Chemistry and Physics.*—Mr. Lawrence, Drs. Leather, Lehmann and Mann, and Mr. Meggitt.
(3) *Biology.*—Messrs. Oldham, Barber and Gammie, Captain Gage and Messrs. Howard and Lefroy.
(4) *Other subjects.*—Messrs. Renouf and Knight, Colonel Morgan and Mr. Smith.

The sub-committees were requested to prepare their respective syllabuses by Thursday, January the 18th. Each sub-committee will then nominate two of its members to form a general committee, who shall co-ordinate the results and submit them to the Board in a consolidated form on Friday, January the 19th.

SECOND DAY.

PROGRAMME OF THE IMPERIAL DEPARTMENT OF AGRICULTURE.

I.—Programme of the Agricultural Research Institute, Pusa.

Dr. Mann asked that the correspondence should be read which contained the suggestions made by some members of the Board for the consideration of the Pusa staff regarding the plan of experiments at Pusa, in response to the invitation contained in paragraph 3 of the Proceedings of the last

meeting, for he considered that the ultimate position as a research station attained by Pusa must stand or fall by the permanent experiments carried on at the institute. These papers are printed as Appendix A.

13. He then proposed that a sub-committee should be formed to discuss the general lines on which the permanent experiments should be framed. This proposal was accepted by the Board and a sub-committee nominated consisting of the following members:—The President, the Director and staff of Pusa, Drs. Mann and Lehmann, Captain Gage and Messrs. Benson, Fletcher and Hayman.

II.—Programme of the Agricultural Chemist to the Government of India.

14. Mr. Knight suggested that the Agricultural Chemist should publish, at stated intervals, all analyses made by him, for the information of those interested. Dr. Leather considered that it is undesirable to publish analyses before a sufficient number has accumulated to allow of average results being arrived at. Drs. Lehmann and Mann concurred with this view. The Board consider that the publication of such analyses must be left to the discretion of the officer concerned.

15. In reply to Mr. Barber, Dr. Leather stated that analyses of sugarcanes during different stages of their growth, so as to test the period of actual ripening, would be arranged for at Pusa. The Board is of opinion that the work of the Agricultural Chemist in field sugarcane analyses in the Central Provinces should be continued. Dr. Mann inquired if arrangements had been made to continue the selection of cane at Pusa on the lines which had already yielded results of considerable interest. Dr. Butler explained that the selection had been primarily with a view to eliminating disease but that attention had also been paid to the general condition of the sets at the time of planting. The former work would be continued on the isolation plots at Pusa. Chemical selection had not been attempted.

16. Dr. Lehmann inquired if it was proposed to construct drain gauges of greater depth than those originally contemplated, as he considered that gauges of nine feet or more in depth could not fail to yield valuable results. Dr. Leather agreed, but stated that the question of undertaking gauges of this size must be deferred for the present.

III.—Programme of the Economic Botanist.

17. Mr. Howard stated in reply to an inquiry from Mr. Bergtheil that he did not now propose to conduct experiments in the improvement of indigo. The cotton experiments which it is proposed to undertake are directed to elucidating certain fundamental questions, such as the methods of fertilization of the flower, which it is desirable to investigate further in order to assist detailed work in improvement by hybridization or otherwise.

IV.—Programme of the Cryptogamic Botanist to the Government of India.

18. Mr. Barber inquired if Dr. Butler proposed to visit Madras to continue the attempts to inoculate the pepper vine with the fungus considered to be the cause of pepper wilt in Madras. Dr. Butler replied that he desired first to investigate the cause of the irregular results obtained with the similar fungus in artificially inducing pigeon pea wilt, and that the pepper wilt will be taken up subsequently.

V.—Programme of the Entomologist to the Government of India.

19. Mr. Benson asked for information regarding certain cotton pests. Mr. Lefroy replied that the information at present available is to be found in an article on cotton pests in the current number of the Agricultural Journal of India. He also stated that an account of this year's ravages of boll worm in the Punjab was in the press, and that the Punjab Department of Agriculture proposes to organize a campaign against this pest in the coming season.

Mr. Benson asked for the Entomologist's views regarding the practicability of introducing insect pests with a view to destroying nut grass—a noxious weed of Madras. Mr. Lefroy stated that the elements of danger in adopting this practice outweigh any possible advantages. Insect pests once introduced cannot be controlled, and are capable of becoming a scourge rather than a benefit, if, as sometimes happens, they pass to useful crops. 20.

The Entomologist stated in reply to Mr. Hayman that he proposed to visit the United Provinces during the coming year. 21.

VI.—Programme of the Agri-Horticulturist.

Mr. Oldham inquired if fresh agricultural probationers may be sent from the provinces on the completion of the training of those already sent. Mr. Shearer stated that more could be taken even now, but Mr. Coventry pointed out that the accommodation for housing them is at present inadequate. 22.

Programmes of Provincial Departments of Agriculture.

Before considering the programmes of the Provincial Departments of Agriculture, Dr. Mann started a discussion on the general principles to be adopted in framing programmes of work. The discussion was contributed to by the President, Messrs. Moreland, Renouf, Lawrence, Benson, Hayman, Drs. Lehmann and Leather and other members of the Board. The following general principles are suggested by the Board as worthy of the attention of Provincial Departments, in view of the contemplated expansion of agricultural experiment work in the provinces:— 23.

1. Farms attached to Colleges should have a portion of their area set entirely apart for the instructional requirements of the students,—the experimental part, where one exists, being carefully separated from the instructional.

2. In view of the danger of multiplying experimental farms with detriment to their efficiency, and to prevent over-lapping, each farm should be founded with a definite object in view in improving the agriculture of its particular tract. In selecting sites, attention should be paid to differences of agricultural conditions and requirements rather than to political divisions, and where two or more provinces possess adjoining similar tracts, it may not be necessary for each province to start a separate farm for its section. In some areas the object in view may be the study of some one crop, while in others general problems connected with changes of cultivation or crops are of greater importance.

3. Experimental farms should not undertake demonstration work or seed production within their experimental area, separate farms or portions of farms being set apart for these purposes. This does not preclude any farm undertaking seed raising so long as the seed areas are kept entirely distinct from the experimental work.

4. In the selection of land for comparative experiments on experimental farms, the necessity for testing the suitability of the soil by uniform cultivation, in order to secure uniformity, should be borne in mind.

5. An important line of work of experimental farms consists in the investigation of means of procuring greater efficiency and rapidity of tillage. With this are bound up the questions of the improvement of work, cattle and of cattle foddor.

The President raised the question of the most convenient form in which programmes of work may be submitted for the consideration of the Board. After discussion, it was decided that a short general statement, giving in a concise and clear form the programme for the coming year, best meets the requirements of the Board. 24.

I.—Programme of the Bombay Department of Agriculture.

25. Dr. Mann alluded to the importance of the question of alkali land in Sind. Mr. Fletcher agreed but stated that as yet comparatively little is known of the causes which lead to the formation of these soils, and that more information and more expert staff are required before the question can be adequately dealt with. The Board desires to emphasise the importance of the study of salt lands in Sind, particularly in newly irrigated tracts, and those in which irrigation is proposed, and considers that the survey undertaken for new canals should include a soil survey.

26. Mr. Fletcher gave some details of the recent progress of the experiments in the introduction of Egyptian cotton into Sind. He stated that the comparative merits of the Abassi and Yannovitch varieties are not yet decided, though Abassi promises to prove the better suited to Sind conditions. The yield to be anticipated this year probably reaches to one or one-and-a-quarter bales per acre, and the valuation in Bombay was about twice that of local cotton. This season's valuations from England have not been received, but no important deterioration of staple seems to have occurred. For next year, it is arranged to have 6,000 acres sown with Abassi cotton.

27. Dr. Butler recommended that experiments in the treatment of ground-nut *tikka* disease should be continued as the results so far were inconclusive. He mentioned, in connection with the question of importing exotic varieties in the hope that disease resistant sorts might be obtained, that the disease is prevalent in East Africa. Mr. Knight agreed that a further trial in treatment is desirable.

II.—Programme of the United Provinces Department of Agriculture.

28. The President enquired what progress had been made in cotton work in the United Provinces during the past year. Mr. Leake stated that a start had been made at Saharanpur in hybridization but that owing to his absence on other duties at a critical period and to frost, no results had been obtained. Mr. Hayman described the progress of the work in selection which had been carried on at the Cawnpore farm. The survey of the existing varieties to provide a sound foundation for future work in the United Provinces had also been commenced.

29. Mr. Moreland described the co-operative seed societies which had been started in the United Provinces. Storage had proved to be a difficulty, and it is probable that Government will have to assist the cultivators in this matter. Wheat, cotton and paddy are thus being distributed.

30. Mr. Gaskin enquired what measures had been adopted for the eradication of *kans* grass, and to what extent they have succeeded. Mr. Hayman said that flooding to a depth of one or two feet in embanked lands had first been tried without success. Now the method adopted was to run the water off after flooding, clean the land when moist and easily worked, and sow a crop of gram immediately. He pointed out that the problem is entirely one of the means at the ryot's disposal, for it has been proved again and again that noxious grasses can be eradicated by the expenditure of money on deep ploughing and good tillage.

31. Mr. Bergtheil enquired what methods had been adopted in soil inoculation with nodule bacteria, and Mr. Hayman described his methods. Mr. Bergtheil then suggested that in order to make sure that the proper organism had been obtained, small tests on sterilised soils should be undertaken before the field tests.

THIRD DAY.

Programme of the Bengal Department of Agriculture.

32. Dr. Mann mentioned a number of experimental investigations of certain crops which he considered might be recommended for the consideration of the Bengal Department. He held that well devised experiments pursued on a systematic plan and directed to elucidating some of the fundamental problems connected with the successful cultivation of a few main crops would be certain-

to give information of the greatest value. He instanced the following crops and experiments as examples :—

I.—Paddy.

(*a*) A survey of the cultivated varieties with the object of determining what varieties exist. This would provide materials for the investigation of the botanical and agricultural characters of the different varieties, and would also incidentally serve as a basis for the rapid introduction of fresh varieties in the event of any variety becoming affected with disease.
(*b*) The investigation of questions connected with the irrigation of paddy, such as the demand for and best method of applying water.
(*c*) The manurial requirements of paddy, more particularly in reference to green manuring.
(*d*) The influence of soil on the quality of the grain.
(*e*) The question of rotation in paddy cultivation.
(*f*) The character of exhaustion induced by paddy.

II.—Jute.

(*a*) The relation of soil to quality of fibre.
(*b*) The bacteriological investigation of the retting processes.
(*c*) A survey of the varieties and an investigation of their characters, both botanical and agricultural.
(*d*) The determination of the proper period of harvesting as regards yield, quality of fibre, and chemical composition of the fibre.
(*e*) Jute rotations.

Other crops, such as indigo, wheat and cotton, he considered as of subsidiary importance ; they are either limited to special areas where, in one case —indigo—they are already provided for, or are best studied elsewhere. The President considered that Dr. Mann had not sufficiently realised the difficulties of the study of these problems in the case of paddy. He held that the cultivation is so highly specialised and the varieties so numerous and so closely dependent on differences of local conditions such as soil, level, aspect, etc., that investigations of such an extended character as those proposed by Mr. Mann are scarcely likely to yield adequate results. He also mentioned the enormous losses of paddy from insect pests, which would quite repay investigation. Mr. Oldham expressed his obligation for the suggestions which had been made and stated that they would receive full consideration by the Bengal Department.

IV.—Programme of the Madras Department of Agriculture.

Mr. Finlow, after briefly reviewing the prospects of successful jute cultivation in certain parts of Madras, recommended that the Department should endeavour to extend the cultivation of Bimlipatam jute—*Hibiscus cannabinus*—which is an efficient substitute for jute proper. The Board considers that while experiments in the cultivation of jute in Madras should be continued, the extension of Bimlipatam fibre would at present more profitably engage the attention of the Department. 33.

Mr. Benson, in reply to Mr. Lawrence, mentioned that imported groundnut seed had been distributed to cultivators about 1896-97 both by the Department and by private individuals, on a considerable scale, the Department's seed coming from the east and west coasts of Africa and the private chiefly from the Mauritius. The distribution was followed by an immediate large increase in the area under this crop, but the previous decrease which had occurred had not been caused by disease, and Mr. Benson was not able to say to what causes the revival should be attributed. It was certainly not solely due to the importation of seed. 34.

V.—Programme of the Punjab Department of Agriculture.

Mr. Lefroy mentioned that much of the cotton seed sown in several parts of India, particularly the Punjab, was worthless owing to the attacks of bugs, from 18 to 45 per cent. of the samples examined this year being attacked. 35.

These damaged seeds can be easily eliminated by rubbing up with cowdung, earth and water to remove the fuzz, then throwing into water and discarding those which float.

VI.—Programme of the Burma Department of Agriculture.

36. The Board has no remark to offer on this programme.

VII.—Programme of the Central Provinces Department of Agriculture.

37. The cause of the curling up and reddening of the leaves of exotic cottons mentioned in paragraph 2 of this programme was enquired by Mr. Lefroy, who suggested that it may be the effect of insect attack. This was considered to be the probable explanation by several members of the Board, as such plants are usually much infested with green fly.

38. With regard to the trials of *caravonica* cotton, several members of the Board gave their experiences with this plant. In Assam Mr. Basu said the growth was strong, the plants reaching 7 or 8 feet in height in two years. A fairly good valuation had been received for some of the lint. In the Central Provinces and Punjab no results have as yet been obtained, but in the latter province it did not appear to stand cold, and was attacked by green fly. In Madras, Mr. Benson said it had been much attacked by borer, and in several places had to be cut back after some months to eradicate this. On light soil in Tinnevelly, it appeared to be doing well. The growth was best on the hill tracts, at an altitude of about 3,000 feet. All the bolls which Mr. Benson had seen were attacked by boll worm.

VIII.—Programme of the Eastern Bengal and Assam Department of Agriculture.

39. Mr. Basu explained that so much new work had fallen on the Department as a result of the creation of the new province, that it had been impossible to draw up a detailed programme of work for the coming year. That submitted was purely provisional, and would require modification subsequently. He briefly described the farms which exist and those which it is proposed to found, and stated that two of them are devoted to special problems, that at Wahjain to tropical products, and that at Rangpur to tobacco. Specimens of cheroots manufactured at the latter were exhibited. He was strongly of opinion that the question of renovating worn-out paddy lands by green manuring should be exhaustively investigated. In again raising the question of the size of plot most suitable for comparative experiments discussed at the last meeting, he explained that at Shillong it had been necessary to adopt very small plots, sometimes only $\frac{1}{160}$ of an acre in size, owing to the small area available and the uneven nature of the ground. Dr. Leather adhered to the opinion expressed last year that $\frac{1}{10}$ acre plots are best, the experimental error being so great as to interfere seriously with the results obtained in smaller plots. This opinion was endorsed by several members of the Board. If small plots are to be adopted at all, they must be very small and under the most rigid control so as to secure absolute uniformity of treatment.

40. Mr. Basu also enquired whether it is best in a continuous series of manurial experiments carried on over a number of years to adhere to the same site or to select fresh sites each year in order to get rid of the residual effects of the manure applied previously. Dr. Lehmann considered the former to be the only satisfactory method. Drs. Leather and Mann, however, held that there is room for both, for the long continued experiments on one site require to be carried on over a considerable period of time before their results can be accepted and in some cases the latter system is preferable.

41. Dr. Mann suggested some modifications in the Eastern Bengal and Assam programme, particularly the abandonment of the Chittagong farm, in which he was supported by Mr. Smith. Dr. Mann held that a central farm at Dacca with a Branch at Gauripur, a hill farm in the Khasi Hills, a sugarcane farm in the Brahmaputra Valley, and a tobacco farm at Rangpur met most of the requirements of the province. The Board considers that the suggestions previously made by Dr Mann on the Bengal Department's programme might be taken into consideration by the Agricultural Department of Eastern Bengal and Assam. (See item 32.)

IX.—Programme of the Mysore Department of Agriculture.

42. The disadvantages likely to arise from laying down definite plots marked off by more or less permanent boundaries at the commencement of the planning of a farm were remarked on by Dr. Leather and agreed to in principle by Dr. Lehmann, both considering that it is best where possible to plough right across the fields each year. Dr. Lehmann, however, pointed out that this is hardly feasible on wet lands, which must be bunded. The President and Mr. Hayman believed that the danger of carrying over manure during cultivation or by surface wash, on plots thus treated, is considerable. Dr. Lehmann said this danger can be overcome by leaving blank spaces between the plots, the spaces serving afterwards as roadways between individual plots.

The Improvement of Indian Wheat.

43. The Board proceeded to the consideration of the lines on which future work in the improvement of Indian wheat should be conducted. In this connection the President stated that the Government of India have recommended the Secretary of State to appoint a special wheat expert.

44. The Agricultural Departments of the several provinces interested in wheat cultivation submitted accounts of the conditions of the crop in their respective areas, and of the experiments which are being carried on by each. A synopsis of this information was prepared by Mr. Howard, and notes on the insect and fungus enemies of wheat by Mr. Lefroy and Dr. Butler. These papers are printed in Appendix B. A note was submitted by Mr. Howard containing suggestions for certain definite lines of work which might serve as a basis for discussion.

45. The Board then considered in detail the suggestions submitted by Mr. Howard. On the proposal that an agricultural survey of the wheats in each province should first be taken in hand, several members of the Board stated that there is a considerable body of evidence that certain of the more important characters, such as the class of grain produced, are liable to marked variation as a result of change of locality. In Bombay and Bengal, cases were quoted of change in character, as for instance from soft white to hard red grain and so on, from this cause. This indicates the need for carrying out the survey in the area to which the varieties belong.

46. On the proposal that the milling and baking tests, which it was obviously necessary to obtain, should be carried out by the Incorporated National Association of British and Irish millers, the advisability of submitting the wheats first to milling and baking tests, on a small scale in a laboratory specially equipped for the purpose in India, was discussed. Mr. Moreland, Dr. Lehmann, and Dr. Leather described the laboratory tests which are carried out in Australia, Canada, and Germany, respectively. Not only new wheats are thus tested but also any others about which information is needed. The tests in Canada gave corresponding results to those obtained on a large scale in the mills, and are generally accepted by the trade. Mr. Howard stated that in England the trade tests are accepted as the best guide.

47. Dr. Mann considered that chemical tests for determining single constituents should also be carried out. It was admitted that these tests had so far yielded no definite results.

48. In answer to enquiries it was suggested that trade tests of macaroni wheats could be obtained in Italy or the United States.

49. The advisability of endeavouring to procure greater uniformity of sample in wheat varieties was discussed. It was stated that a demand for pure varieties exists in certain provinces to a limited extent, but admixture to bring down wheats of high purity to a trade level is deliberately carried on by dealers. Until a definite demand for pure grain is created by the trade, the Agricultural Departments can do very little. The matter had been considered very fully by those interested on previous occasions, but it had been recommended by all Chambers of Commerce and other responsible bodies consulted that interference was at present inadvisable.

50. The following scheme of experiments for the improvement of Indian wheat is suggested by the Board:—

SCHEME FOR FUTURE WORK ON THE IMPROVEMENT OF INDIAN WHEATS.

1. *The Agricultural Survey of the wheats in each province.*—It is clear that a reliable survey of the wheats of each province must be made before the question of wheat improvement can be seriously taken up. It will be necessary to know, with a fair degree of accuracy, the general agricultural characters, distribution as regards area and type of soil, rust and drought-resisting power, and the suitability of the grain for local use and export in the case of the chief varieties grown. Without this preliminary knowledge of the question, any hybridization experiments and indeed any fundamental experiments whatsoever must be haphazard, and most valuable time might easily be lost by working in the dark. Considerable progress has already been made in the direction indicated, and before long it is expected that this introductory work will be completed in all the provinces concerned.

2. *Milling and baking tests.*—The export of wheat from India, although small as compared with the total production, is already of considerable importance. Most of the wheat sent away is used for bread-making, the rest for the manufacture of macaroni. It appears desirable, therefore, that reliable milling and baking tests should be made of the chief varieties of Indian wheats so as to determine their relative value and also their behaviour as compared with other wheats imported into the United Kingdom. The milling and baking characters largely determine the export value of any variety, and it appears impossible at present to determine the value of any wheat except in this manner. The simplest method of obtaining this information, when the provincial wheat survey is completed, would appear to be to secure the co-operation of the Incorporated National Association of British and Irish Millers. Suitable samples of the various types grown in India could be sent to England and their milling and baking characters determined. Photographs of loaves made from equal weights of flour of each variety could be made and compared with those of the best American and Canadian wheats imported into England. The Association of Millers referred to are conducting similar tests in England in connection with the experiments now in progress for the improvement of English wheats. It would not be difficult, therefore, to enlist their assistance with regard to Indian grown wheats. The information thus collected could not fail to be of the greatest value and interest generally and specially useful to those in charge of experiments on wheat improvement in India. The Board considers that the desirability of carrying out laboratory tests on milling and baking properties of wheat in India, in a laboratory specially equipped for the purpose, is a matter for future consideration after the appointment of the wheat expert.

3. *Uniformity of sample.*—Although some cultivators do their best to keep the varieties pure, it is clear that a large amount of the wheat grown in India consists of a mixture of various types. Both from the point of view of local consumption and export, the growth of a mixture of varieties is, on the whole, to be deprecated. In the first place, the varieties are not likely to ripen at the same time and secondly, an impure sample gives rise to difficulties from the miller's point of view and consequently commands a lower price. No doubt when suitable wheats have been found for districts like Bundelkhand, where at the present time varieties are sometimes intentionally mixed as a form of insurance against a total failure of the crop, the practice of mixing will be discontinued. It seems probable that purity of sample may be encouraged in three ways, firstly, by extending the present system of distributing pure seed from the seed farms so as to admit of cultivators obtaining seed, true to type, independently of the local grain dealers and money-lenders; secondly, by the publication in the vernacular of the difference in price obtained for pure and mixed samples; and thirdly, by a system of seed distribution on a large scale upon the lines already successfully worked in the United Provinces. The Board, however, consider that this is a question primarily for the consideration of the trade.

4. *Rotation experiments.*—In the Punjab especially, the growth of leguminous crops in the rotation does not seem to be adopted to the same extent as

in other parts of India. It seems desirable, therefore, that experiments should be made on this question in districts where it is not usual to grow leguminous crops on wheat lands.

5. *Adulteration.*—As the admixture of foreign matter to exported wheat takes place after it has left the grower, it is impossible for the Agricultural Departments to take any action to prevent this adulteration. The Board considers that this is also a matter purely for the consideration of the trade.

6. *Storage.*—The damage done to grain during storage by damp and weevils seems to be worth attention and the method adopted in the Punjab of keeping grain in houses instead of in pits might be tried. The use of insecticides like carbon bisulphide may be applicable in India. The Board consider that this question should also be deferred until the wheat expert arrives.

7. *Transport difficulties.*—Most of the wheat exported is moved before the rains, and on the railway to Karachi especially, the supply of waggons is said to be too small to cope with the volume of wheat ready for transport. Definite information on this point and also on the railway charges for wheat in India might be collected with advantage. The Board, however, consider that this is a question for the public to deal with and that they cannot suitably move in the matter.

8. *Experimental work on the improvement of Indian wheats.*—In wheat, as in the case of other crops, the growth of exotic varieties in India has not proved a success, nor is it likely that any particular variety will be found suitable for the whole of the wheat-growing tracts. Each province seems to have its own problems and it appears desirable, therefore, to develop the present experiments and experimental farms conducted by the Provincial Agricultural Departments.

At the present time the local consumption of wheat in India is far greater than the export trade. The local aspect of the question is, therefore, of considerable importance. In some of the wheat-growing tracts, the problem is to find a wheat which will mature at all under the moisture and soil conditions prevailing, and in these regions the question of export need not for the present be considered.

The importance of the variety in the case of wheat cannot be overestimated. It would appear to be of greater importance than any of the other factors concerned, such as soil, cultivation, or manurial treatment. Efforts should, therefore, be directed to the production of new varieties by cross-fertilization, suitable for the various districts. In the southern portion of the wheat-growing tract—Bengal, the Central Provinces, Bombay and parts of the United Provinces—the need of rust-resisting varieties is of the greatest importance. In regions of precarious rainfall where irrigation is not available, varieties which mature with the minimum of moisture are wanted. In more favourable districts the aim of the breeder should be in part to produce wheats with milling and baking qualities suitable for export purposes. The hybridization experiments will, therefore, have to be modified according to circumstances, and the aim of the plant-breeder in the various provinces will not necessarily be the same.

Of equal importance to the production of new varieties is the method adopted in distributing them to the actual cultivator. Unless this distribution is adequately controlled and the resulting crops kept under observation, it will be easy to obtain results which would condemn a variety of real value. The Board, however, believes that no considerable difficulties in introducing the improved varieties into cultivation need be anticipated.

The Improvement of Indian Tobacco.

51. The Board considered this question on similar lines to those followed in dealing with wheat. Notes on the conditions of tobacco growing and curing in the various provinces were submitted by the departments concerned and a synopsis prepared from these notes by Mr. Coventry. Mr. Benson also exhibited some samples of Madras tobaccos. Mr. Lefroy and Dr. Butler submitted short notes on the chief insect and fungus pests of the crop. These papers are printed in Appendix C. A scheme for future work was submitted to serve as a basis for discussion.

52. The President stated that the Government of India has recommended the appointment of a tobacco expert to the Secretary of State.

53. The Board then proceeded to discuss the detailed suggestions for future work.

54. On the question of a survey of existing varieties, several members again emphasised the danger of applying conclusions drawn from experiments carried on in one locality to others of different climatic and agricultural conditions.

55. The Board submits the following suggestions as a provisional scheme of future work for the improvement of Indian tobacco :—

SUGGESTIONS FOR A SCHEME OF EXPERIMENT FOR THE IMPROVEMENT OF INDIAN TOBACCO.

1. *Area for Experimental Work.*—The provincial reports seem to indicate that experiments in tobacco should, for the present, be confined to the following tracts :—

(*a*) the Coimbatore and Dindigul tract of Madras;
(*b*) the Godaveri Delta of Madras;
(*c*) the Rangpur tract of Eastern Bengal;
(*d*) the delta tract of Burma;
(*e*) Behar in Bengal;
(*f*) Guzerat in Bombay.

2. *Study of existing conditions.*—It would seem that, at least in some cases, the existing methods of tobacco cultivation and curing have not been thoroughly studied, and that the first step towards improvement should be a careful inquiry into such methods. This inquiry should specially be directed to ascertain the causes of the very different qualities of tobacco produced at different gardens.

3. *Study of Tobacco Soils and Waters.*—This inquiry should be supplemented by an investigation of tobacco soils, both as regards their physical texture and chemical composition. In addition, there should be a study of the well waters used for irrigating tobacco.

4. *Survey of local varieties.*—A careful survey of all varieties grown in each tract should be made by growing them under observation at a suitable Government Farm, in which all their characteristics, qualities and the like should be determined. This should decide which is the best local variety for the tract. At the same time, the whole of the Indian varieties should be grown at Pusa for a comparative study of their characters.

5. *Object of the experiments.*—It does not appear that there is much scope for improvement in the production of tobacco suited for native consumption except by increase of yield, so that the main object should be to test the possibilities of producing tobacco for European consumption suitable for (1) cigar wrappers, (2) cigar fillers, or (3) pipe and cigarette tobacco.

6. *Trial of Exotics.*—For this main object, trials should be made in the cultivation of foreign varieties, including American, Cuban, Spanish, and the tobaccos of Java and Sumatra, in addition to the best local varieties.

7. *Improvement in methods of cultivation.*—There is not sufficient information generally available for the suggestion of definite experiments directed towards the improvement of existing methods of growing tobacco, but field tests might be made with the following, amongst other, objects :—

(*a*) experiments in the spacing of plants to test the result in regard to (1) yield, and (2) quality;
(*b*) manurial experiments, particularly with potash manures, in which plant food the Indian soils are said to be generally deficient for the production of good tobacco;
(*c*) experiments in topping plants at different stages of growth to test the result in regard to (1) yield, and (2) quality;
(*d*) experiments in the economical use of water in irrigation.

Experiments in growing tobacco under shade may for the present perhaps be tried in some parts, but it is believed to be generally beyond the resources of the country.

8. *Improvement in methods of harvesting.*—Experiments should be made to test the different systems of harvesting and subsequent curing of (*a*) whole plants, (*b*) plants split into parts, and (*c*) priming or removal of leaves.

9. *Improvement in methods of curing.*—This offers the largest field for experimental work with the greatest possibilities of improvement. Under the guidance of an expert tobacco curer, one series of experiments should be started to test the quality of tobaccos under a system of curing under complete control of conditions of temperature and moisture in a properly constructed tobacco-curing house. Secondly, experiments should also be made to ascertain whether the advanced methods of curing followed in other countries can be adapted to suit local Indian conditions. Thirdly, experiments should be made with the local methods of curing to see if simple improvements can be effected within the scope of the Indian curer.

FOURTH DAY.

Agricultural Stock and other Veterinary Matters.

Colonel Morgan brought the consideration of some questions of consider- 56.
able importance before the Board. The first of these was the danger of curtailing grazing grounds. This danger lay chiefly in the effect of diminished grazing ground on breeding. In Madras considerable areas previously available for grazing are now included in forest reserves. In other parts the increase of irrigation has led to whole districts being brought into arable cultivation at the expense of pasture lands. In the Jhelum colony absolutely no grazing facilities exist.

The second matter on which he desired the Board's opinion was the best 57.
method of employing the services of veterinary assistants, *i.e.*, whether the stationary or itinerating method is preferable.

Mr. Hayman brought before the Board a consideration of the best methods 58.
of providing fodder in times of famine.

These subjects were discussed at length by the Board, the general feeling 59.
being that sufficient time had not been given for their consideration and for obtaining the necessary information.

The Board suggests that, in view of the importance of these matters, the 60.
Government of India should be asked to request Local Governments to collect information, which would then be laid before the next meeting for their careful consideration. They consider that in the meantime a botanical investigation of fodder grasses should be undertaken for those provinces in which this has not already been done.

The Use of Commercial Fertilisers in India.

Mr. Benson stated that in his opinion the introduction of the use of 61.
artificial manures is one of the most promising lines of work of the Agricultural Departments. Mr. Patel and Dr. Lehmann agreed with Mr. Benson, the former complaining of the difficulty of obtaining such fertilisers at reasonable rates in Bombay. Mr. Meggit supplied the Board with quotations for the chief artificial manures in Bombay and compared them with the prices of similar manures in England. Dr. Mann supplemented these with some quotations of Calcutta prices. He was not satisfied that sufficient use is being made of local fertilisers and would prefer to see the local supplies fully developed before importation is pushed. Mr. Coventry said it was a question of cost and so far as Behar was concerned, phosphatic manures could be introduced at a much cheaper rate than any local supply.

The President stated that a supply of ammonia in India would be available 62.
as a bye-product resulting from the use of recovery coke ovens such as are in work at the East India collieries. It would seem advisable to carry out experiments in the use of sulphate of ammonia, particularly as a manure for sugarcane, since in Java this is the chief fertilizer used by the sugar planters. Several members of the Board advocated the use of this manure while, however, remarking that injurious effects had resulted from its application in certain soils.

63. The Board is of opinion that experiments in the use of sulphate of ammonia as a manure, particularly for sugarcane, should be carried out by the Agricultural Departments.

64. A request from the Madras Board of Revenue to the Inspector General of Agriculture that he should refer to the Board of Agriculture the question whether it is advisable for the Agricultural Departments in India to undertake the inspection and control of commercial fertilizers was laid before the Board. Suggestions for legislation for the inspection and control of artificial manures by Government were submitted by Mr. Benson. These suggestions were that an Act on the lines of those summarised in the article on the "Inspection of fertilizers" in the volume entitled "Agricultural Experiment Station in the United States," dated 1900, should be passed; the work of inspection to be committed to the Agricultural Chemist of the provincial Research Stations. Information concerning the systems in force in America, Germany and England was supplied by Drs. Lehmann and Leather. These papers are printed in Appendix D.

65. After discussion it was resolved that a committee should be appointed to consider the whole question and report to the next meeting, the committee to consist of the following members:—Mr. F. G. Sly, Drs. Leather, Mann and Lehmann, and Messrs. Moreland, Benson and Coventry.

Report of the Sub-Committee appointed to advise on the Programme of Research work at Pusa.

66. The following report of the committee appointed to advise on the programme of research work to be undertaken at Pusa was considered and approved by the Board:—

The committee confined itself to a discussion of the outlines of the policy underlying the permanent experiments at the Pusa Agricultural Research Institute and to the immediate action to be taken to prepare for such work. They are not in a position to frame the details of any definite scheme of permanent experimental work.

Regarding *policy*, the view was expressed that the work should be distinctly imperial in character, involving the application of the principles of each science to broad general problems of Indian agriculture, and that investigations of local importance only should not, as a rule, be undertaken. There must necessarily be exceptions to this general principle, particularly in the present stage of development of provincial departments, who must rely upon the assistance of the Pusa staff in some local investigations.

The Committee suggest the following general outline for the research work of the Pusa Institute:—

A.—Agricultural Chemistry.

(1) *Plant nutrition investigations.*—The mode of transmission of food to the plant. It has been assumed that the food of higher plants is assimilated in solution, but at present the data on which an estimate of the velocity on which these solutions move either downwards during periods of wet weather, or upwards during those of dry, or by diffusion, are extremely imperfect.

(2) The availability of phosphate and potash in soils, which is another branch of the main subject of the mode of transmission of food to plant, though the methods employed are necessarily at present empirical.

(3) The other subjects at present engaging the attention of the Agricultural Chemist, such as the cyanogenesis in plants, are regarded as subsidiary. The amount of time at present devoted to the analysis of materials for Provincial Departments is considerable, but it seems likely that this will diminish now that it is intended to appoint chemists to the provinces.

B.—Cryptogamic Botany.

The research work in this branch falls at present under two main heads:—

(*a*) the investigation of soil fungi;
(*b*) the study of plant diseases.

The former embraces a field about which but little is known ; and involves several problems of importance. The work will doubtless be difficult an may lead to no positive result in any short time.

The latter includes a study of fungus diseases, some of which are fairly well known, but whose ætiology is very imperfectly understood, and it is proposed to take up their study from this point of view. Definite results will not be reached readily. When provincial specialists are available for the study of local plant diseases, the imperial Mycologist will more largely restrict his attention to these two main subjects.

C.—Entomology.

The entomological work must necessarily, for the present, be largely provincial in character, because the provincial departments are as yet unable to deal with their own problems. Ultimately, however, the principal line of work should be a study of the insect pests of India, more particularly in regard to the conditions of climate, soil and other factors governing their distribution and prevalence. The work should also include systematic entomology, and the Pusa staff should be in a position to guide and co-ordinate the entomological work of provincial departments.

D.—Bacteriology.

(*a*) The applications of bacteriology to the investigation of the methods of plant nutrition on Indian soils. This is a subject about which nothing is yet known and in which almost anything learnt is of a fundamental nature.

(*b*) The investigation of processes involving bacteriological study, such as nitrification and denitrification and such like known processes, which have been studied to some extent in other countries, will have to be taken up for India where the conditions are very different.

(*c*) The decay and fermentation of dung and other organic manures, of which comparatively little is known in temperate climates and practically nothing in subtropical ones.

(*d*) Problems of less fundamental nature but still of general importance in India are such as the application of inoculation to Indian soils, and crop and plant diseases of a bacterial nature. Further, the fermentation processes due to enzymes, which play a prominent part in many agricultural processes, are deserving of careful attention so that they may be compared with one another and general lines for their study evolved.

E.—Economic Botany.

The main line of work will be the investigation of the scientific principles which underlie plant-breeding and plant improvement in India. In addition there will be permanent experiments on fruit culture and a special garden for fibre plants.

The work in Economic Botany requires at present an area of 75 acres of land, which has been allotted, but later on an additional plot of about 25 acres will be wanted on the farm.

F.—The Experiment Farm.

In order to secure suitable fields for experimental work, the land should be cultivated uniformly, with either no manure or very restricted quantities of it, and a record maintained of the productiveness of the several parts of the land as evidenced by the yield of crop. This part of the programme should be taken in hand for Pusa at once. Altogether a maximum of 150 acres should be treated in this manner. The areas, from which separate weighments are to be recorded, must depend on circumstances, but a unit of one acre is suggested as an indication of what would probably meet the requirements of the case. This must, however, depend on a preliminary personal survey of the crops.

It is also suggested that investigations into the feeding value of Indian cattle foods should be taken up when the Chemical branch can start it.

The Procedure at the meetings of the Board of Agriculture.

67. The Board then considered some suggestions made by the President for the improvement of the procedure at present followed at the meetings of the Board. The increasing number of the members and the important questions placed before them seem to demand that more opportunity should be given for members to formulate their mature opinions than is possible under the present procedure.

68. It was agreed that the main subjects for discussion at the next year's meeting should, with the approval of the Inspector General of Agriculture, be settled so far as possible at the close of each meeting. This will give members time to prepare the material necessary for a full consideration of each subject. The system of selecting one or more important crops as the main subject of discussion has worked well and might be continued. For next year's meeting, the Board recommends the following programme for the main subjects of discussion:—

(1) The confirmation of the proceedings of the last meeting.

(2) The programme of the work of the Imperial Department of Agriculture.

(3) The programmes of work of the Provincial Departments of Agriculture.

(4) Sugarcane.

(5) Veterinary. (See Items Nos. 56 to 60 of present proceedings.)

It is almost inevitable that some other subjects will arise during the year, which may with advantage be placed before the Board, so that such a programme can only be provisional. In some cases, even at the last moment it may be necessary to add some subject, but such cases should be very exceptional.

69. It was agreed that it is difficult for the Board to perform its full functions as an advisory body, even with a fixed programme announced well in advance of the date of meeting, unless each member can receive all the reports and other papers relating thereto in ample time to admit of their careful consideration before the meeting. Moreover, it is sometimes the case that these reports require to be correlated, and definitive schemes to be framed, for the consideration of the Board. It is, therefore, of the utmost importance that the reports should reach the Inspector General of Agriculture much earlier than has been the case in the past. A period of three months is required to allow time for their printing, correlation, and circulation to members. It would also be a great advantage if members could receive all papers two months before the meeting. All papers should, therefore, be sent to the Inspector General of Agriculture five months before the meeting.

70. The time of the Board is sometimes taken up by members bringing forward, with insufficient or no notice, questions which demand more time for consideration than the Board as a whole can give at the actual meeting. It would facilitate the despatch of business if members would communicate remarks on the programme of the Board in sufficient time to allow of such notes being printed and circulated to members some time before the date of meeting. It was agreed that the members should endeavour to communicate such notes one month before the meeting, which will give them one month for the preparation of such notes, if punctuality is observed in the distribution of papers. It is not suggested that discussion should rigidly be confined to the points raised in such notes, but such a system will facilitate the despatch of business.

71. The Board also agreed that the President should be empowered to refer, if it seems to him desirable, any questions that may arise in the interval between the annual meetings, to committees selected by him, in time to allow of such committees considering the questions referred to them in meeting or in circulation, and submitting their reports to the President, so that they may be printed and circulated to all members before the next meeting.

Locality and date of the Annual Meeting.

72. The advisability of holding some of the annual meetings of the Board in provincial agricultural centres was suggested by several members. After discussion the Board decided to recommend to the Government of India that the annual meetings should be held in alternate years at Pusa and in the Provinces. It was agreed to ask the Government of India to suggest to the United Provinces Government that the next meeting should be convened at Cawnpore.

73. The date of the meeting was discussed and it was agreed that about the third week of February was the most convenient date for the majority of the members, if the meeting was held at Cawnpore.

FIFTH DAY.

Agricultural Education.

74. The Board considered the report of the committee appointed to co-ordinate the syllabuses prepared by the sub-committees nominated on the first day of the meeting in the main sections of agricultural education. The following standard curriculum was accepted by the Board after a discussion of the detailed syllabuses.

Standard Curriculum for Agricultural Colleges.

This curriculum is arranged on the assumption that the course can be most conveniently divided into the following time-table :—

Subject.	Number of working hours per week.				
	1st year.	2nd year.	3rd year.	Average.	Percentage of total.
Agriculture	12½	14½	13	13	40
Physics and Chemistry	5	10	11	8⅔	27
Biology { Botany	5	4	4½	4½	14
Biology { Zoology and Entomology .	1½	2½	2½	2⅓	6
Veterinary	3	1	2	2	6
Agricultural Engineering, local system of Land Records and English . .	6	1	...	2⅓	7
Total . .	33	33	33	33	

Agriculture.

Note.—The methods of outdoor teaching must vary greatly from province to province, and the committee is not prepared to lay down a uniform scheme either of the methods to be followed or of the period of their introduction. They suggest, however : (1) that cultivation of plots by individuals should be introduced as early in the course as may be practicable, and certainly not later than the second year; (2) that at the beginning of the course the students should be trained to observe and perform the ordinary processes of farming as practised on the college farm, and that the area of observation should be extended gradually as the power of observation develops; (3) that instruction in the methods of agriculture should be given almost entirely in the fields or the farm yard, and not by text-books or in the lecture room; (4) that when methods and processes have been mastered in detail, sufficient attention should be given to the organization and working of the farm as a whole.

A.—PRELIMINARY.

1. *Introductory*—
   History.
   Scope.
   Objects.

2. *Geology*—
   The crust of the earth.
   Rocks, and rock-weathering.
   Formation of soils.

3. *Meteorology*—
   Relation of geographical position (including altitude) to rainfall and temperature.
   The seasons: character and causes.
   The effects of dew, frost, and hail.

4. *Application of geology and meteorology to the province.*

B.—CULTIVATION.

5. *Soils of the province*—
   Classification and distribution.
   Properties of the various soils and subsoils.
   Treatment of defects.*

6. *Tillage*—
   Objects of tillage.
   Methods and implements.

7. *Manures*—
   Sources of manure.
   Conservation.
   Methods of application.
   Methods of action.
   Comparative agricultural values.

8. *Sowing*—
   Conditions favourable to germination.
   Choice and care of seed.
   Methods of sowing, and implements.
   Improvement of seed stocks, by selection and otherwise.*

9. *After-tillage*—
   Objects and methods.

10. *Irrigation and drainage*—
    Sources of irrigation-water.
    Methods of raising water.
    Application of water to the land.
    Water requirements of crops.
    Regulation of drainage.

11. *Harvesting*—
    Methods and implements of harvesting.
    Preparation of the final product.
    Storage of produce.
    Estimation of outturn.*

12. *Crops and cropping*—
    Field crops.
    Garden crops.
    Orchards.
    Choice of crops to suit local conditions.
    Rotations including fallowing, and mixed crops.

Note.—If necessary, the subjects marked with an asterisk can be postponed to the third year.

C.—LIVE STOCK.

13. *Breeds and breeding* (of animals important in the province).
14. *Management.*
15. *Dairying.*

D.—RURAL ECONOMY.

16. *Farm equipment*—
    Requirements of live and dead stock and working capital.
17. *Farm management*—
    Supply of capital.
    Labour-supply.
    Reclamation and improvement of land.
    Disposal of produce.
    Farm accounts.
18. *Conditions influencing the value of land.*
*19. *Principles of estate management*—
    Selection of tenants.
    Provision of capital for tenants.
    Improvements.
    Fixing rents.
    Collecting rents.
    Accounts.
*20. *Law of landlord and tenant*—
    Fixity of tenure.
    Right to improve.
    Limitation of rent.
    Record of rights.

* For zamindari provinces only.

PHYSICS AND CHEMISTRY.

Note.—It is generally agreed by the committee that the system which has been employed hitherto for giving instruction in chemistry to agricultural students is defective, especially in the laboratory course. The processes of general qualitative and quantitative analyses may be, and usually are, executed by students in a very mechanical manner, and fail to render them much assistance in the study of the chemistry of those substances which play so important a part in agriculture.

For this reason an endeavour has been made to construct a course for the laboratory by which this defect may be remedied. It includes a practical study of the principal properties of typical substances, and their quantitative preparation. The aim in view is to induce students to think, and to understand the nature of the processes involved, instead of carrying out stereotyped exercises. It will be further noticed that, in the course on general chemistry, no distinction has been made between the Organic and Inorganic chapters, and that it has been restricted so as to include only those subjects which are of direct service to a proper understanding of the agricultural chemistry course.

The laboratory work in physics will naturally take precedence to that in chemistry. The latter is radically different from those common to most schemes. The object in view is to bring the student into personal contact with such matters as are directly related to agriculture. Qualitative and quantitative analyses are excluded and more useful experimental work takes their place. The introduction of this will necessitate several precautions. Firstly, the demonstrators *must* pass through a preliminary training, so as to become personally familiar with the technique of the experiments. Secondly, opportunity should be given to the aptest students to commence the chemical laboratory work in advance of the others immediately they have completed the physics course and gradually the whole class will become acquainted with the laboratory methods prescribed. Thirdly, the plan under which the demonstrator makes the experiment on a raised platform before the whole class, followed by an attempt by the latter to copy him, is foreign to the design. It should be recognised that one demonstrator cannot successfully take charge of a large batch of students and the latter should ordinarily be limited to about fifteen.

Physics.

General.

The measurement of length, area, volume, time.
Force, weight, pressure, tension.
Energy.—Work, power, conservation of energy, simple machines, the balance.
The different states of matter.
Solids.—Properties and structure.
Liquids.—General properties; hydrostatic machines.
Specific gravity of solids and liquids.
Solution, diffusion, osmosis, capillarity.
Gases.—General properties.
The atmosphere; barometers.
Isobars, cyclones and anti-cyclones.
Water-pump, air-pump.

Heat—Laboratory Course.

Temperature, expansion and contraction, thermometers.
Specific heat.
Conduction, radiation, convection.
Circulation of the atmosphere, winds.
Change of state, fusion and solidification, vaporization.
Latent heat.
Tension of vapours, dew.
Transformation of heat energy into mechanical energy.
Sources of heat energy.
Cooling by expansion of gases, and heat by compression.
Production of clouds and rain by rising currents of moist air.

Laboratory Course—List of practical exercises.

1. Construction of vernier scales for measurement of length and angles.
2. Measurement of metal sheets, wires, and other regular solids with vernier callipers.
3. The same measurements with the screw micrometer.
4. Calculation of volumes, weighing and determination of densities.
5. Density of a solid by weighing and then displacing water in a partly filled graduated vessel with the solid.
6. Specific gravity of heavy solids with the hydrostatic balance.
7. Specific gravity of light solids with the hydrostatic balance.
8. Specific gravity of liquids with the specific gravity bottle.
9. Specific gravity of solids with the specific gravity bottle.
10. Specific gravity of liquids with hydrometers.
11. Joly spring balance. Construction of curve showing relation between stretching and weight.
12. Simple pendulum.
13. Measurement of the energy required to raise a body a certain distance by means of different combinations of pulley.
14. Measurement of the energy required to raise a body a certain distance by means of the wheel and axle.
15. Breaking weights.
16. Solubility of different substances.
17. Capillarity with tubes.
18. Capillarity with plates.
19. Boyle's Law and Gay Lussac's Law.
20. Daily or weekly readings at stated times of the thermometer, barometer, maximum and minimum thermometer and wet bulb thermometer. Annual curves to be drawn.

21. Construction of a water thermometer.
22. Specific heat, method of mixture.
23. Heat of fusion of ice.
24. Heat of vaporization.
25. Observation from day to day, at different temperatures, of vapour tension in barometer tubes containing water, alcohol and ether.
26. Hydrometers.
27. Siphon.

Note.—One hour's lecture a week for the first year. Three hours' laboratory work for two-thirds of the first year.

Chemistry.

General Chemistry.

(It is expected that the course on General Chemistry will be completed by the middle of the second year, so as to allow about a year and a half for the course on Agricultural Chemistry).

Definitions.—Molecule, atom, element, compound, mixture; symbols, formulæ, chemical action, equations, molecular and atomic weights, nomenclature.

The preparation and chief properties of the following elements: Oxygen, Hydrogen, Nitrogen. The composition and chief properties of the atmosphere and pure and natural waters. Oxidation. Basic and acid oxides. The source, preparation and chief properties of the following elements and compounds: the Halogens, Hydrogen chloride, Sulphur, Hydrogen sulphide, Sulphurous and Sulphuric acids, Carbon, Carbon dioxide, Silica, Ammonia, Nitric acid, Phosphorous, Phosphoric acid, White Arsenic. The source, preparation and chief properties of the following metals, oxides and salts: Sodium, Potassium, Ammonium, Calcium, Magnesium, Aluminium, Iron, Lead, Copper. The chief oxides and salts of the alkali and alkali-earth metals, Alumina, Alum, Ferric oxide, Ferrous sulphate, Cupric sulphate.

Carbon compounds. Their general composition. Physical properties. General classification.

The Hydrocarbons—the Paraffins. Alcohols—Methyl and Ethyl.

Glycerine. Fats and Oils.

Acids.—Formic, Acetic, Butyric, Oxalic, Lactic, Citric, Tartaric, Palmitic Stearic, Oleic. Soaps.

Carbohydrates.—Cane sugar, Dextrose, Levulose, Maltose, Starch, Dextrin, Cellulose, Gums, Application of Polariscope.

Cyanogen compounds.—Hydrocyanic acid. Potassium cyanide.

Phenol, Salicylic acid, Gallic acid.

Tannin, Indigo, Nicotine, Morphine, Quinine, Strychnine. Terpenes and Camphors, Caoutchouc, Resins, Glucosides. Albumens and Albumenoids.

Chemistry of Agriculture.

(1) *The soil.*—Origin of soils.—Weathering. Composition of rock minerals and their weathered products.

Nature of soil constituents, sand, clay, chalk and humus. Methods of sampling soils. Mechanical analysis and interpretation of results.

Texture of the soil.

Pore space.

The water of the soil.

Temperature of the soil.

Chemical analysis of soils:—Interpetation of results. Dormant and available plant food. Analysis of the soil by the plant. "Available" phosphoric acid and potash. Analyses of typical Indian soils

The living organisms of the soil.—Decay and humification of organic matter in soil. Fixation of free nitrogen by bacteria.

Nitrification and denitrification.

The power of the soil to absorb salts. Retention of manures.

Composition of drainage waters.

Causes of fertility and sterility of soils.—Drought, water-logging, presenc of injurious salts.

The amelioration of soils by liming, burning, etc.

(2) *Fertilizers.*—Organic and mineral.

(3) *The plant.*—Proximate and ultimate constituents of plants. Chemic composition of seeds and stems of crops. Assimilation of food, its products an their transformation. Chemical changes during germination.

Methods of analysis.

(4) *Agricultural Animals.*—The chief constituents of the animal bod Relative value of food constituents to repair loss. Adaption of food to requir ments of animals under different conditions of life. Relation of food t manure.

(5) *The Dairy.*—Constituents of milk and their relative amount. Con position of cream, butter and cheese. Changes in dairy products due t fermentation.

Laboratory Course.

The atmosphere. Examination of its constituents and the estimation o their relative quantities.

Oxygen.—Preparation and properties.

Water.—Its qualitative and quantitative examination, its solvent power an its chief physical properties.

Hydrogen.—Preparation and chief properties.

Chlorine and Hydrogen chloride.—Preparation and chief properties.

Nitrogen and Ammonia.—Preparation of Ammonia from Organic materi proof of composition of Ammonia.

The chief oxides of the alkalis and alkaline earths, and Ferric oxide an alumina; their preparation and chief properties.

Demonstration of combining proportions, preparation of the several pho phates quantitatively, proof of the composition of Copper oxide and Ferr oxide.

Carbon and Carbonic acid.—Forms of Carbon, chief properties, preparati and chief properties of Carbonic acid.

Salts.—Preparation of such salts as Potassium sulphate, Calcium pho phate, Sodium chloride, Ammonium sulphate, Calcium carbonate, Calcium b carbonate. This work to be carried out quantitatively.

Carbohydrates.—Demonstration of the chief properties, proof of the presence in vegetable kingdom, fermentation of sugars, and proof that alcohol formed.

Oils.—Vegetable and mineral.—Chief characteristics.

Albumenoids.—Preparation and properties of wheat gluten, egg albume and milk casein.

Mechanical analysis of soils by the sedimentation method, effect of pu dling on soils.

Feeding stuffs.—Proof of the presence of the chief constituents.

Milk.—Use of lactometer and proof of the presence of chief constituents.

Biology.

Note.—The Committee considered a scheme of teaching in botany propos by Mr. Howard, under which from the commencement of the course the thr groups—morphology, anatomy, and physiology—would be combined and inte woven into a connected whole, instead of being taught separately, so that the various aspects of the subject may be presented to the student as a whole in order to give him a connected account of the complete flowering plant Whilst the committee agree that this system of teaching elementary botany is based upon a logical scientific principle, and has very much to recommend it, they consider that it cannot be adopted in the present conditions of teaching in Agricultural colleges, owing to the want of a suitable text-book and the fact that Indian teachers are not trained in the method. It was, therefore, decided frame a syllabus upon the lines ordinarily followed. This has been prepared

in a skeleton form so that the details may be settled in accordance with the botanical flora of each province concerned. At the same time a syllabus, prepared by Mr. Howard in accordance with his proposal, is attached, with a view to its consideration by provincial departments, and its ultimate introduction, if it meets with acceptance when the difficulties mentioned above are removed.

Botany.

(5 hours a week first year, 4 hours a week second year, 4½ hours a week third year.)

Elementary Botany.—General life history of a flowering plant, from the seed onwards. Morphology—special morphology of the root, stem, leaf, inflorescence, flower, fruit and seed. The elements of general plant anatomy. The chief physiological processes—transpiration, respiration, assimilation, growth. Influence of environment. Reproduction, germination.

(This course will include practical work out of doors and in the laboratory.)

Agricultural Botany.—Classification, description and uses of plants of agricultural importance in the province, including practical work in the field and laboratory.

Cryptogamic Botany; main groups of cryptogams, algæ, fungi, lichens, mosses, ferns.

Diseases of plants.

Improvement of Agricultural plants.

Special course on Horticulture, including fruit culture, suited to the conditions of the province, if this subject is not dealt with otherwise.

Alternative Syllabus in elementary botany.

The chief types of flowering and flowerless plants, illustrating the range and variation in habitat of the groups of plants comprised in the vegetable kingdom.

The chief organs, root, stem, leaves, flowers, fruits and seeds of common agricultural examples of flowering plants.

Seeds and seedlings.—The structure of seeds. Germination. Germination energy and Germination capacity. The food materials in seeds such as starch grains.

The root.—Development of the root from the embryo of the seed. Root hairs and their uses. Root storage. Adventitious roots.

The stem.—Development of the stem from the embryo of the seed and from buds. Forms of stems. Structure of stems. Vegetative reproduction in grafting, budding and growth from cuttings.

The leaf.—The forms of leaves. The structure of a green leaf. The functions of the leaf, transpiration, assimilation and respiration. Translocation and storage of food.

Inflorescences and flowers.—The parts of flowers. Form of flowers. Pollination and fertilisation. The development of seeds.

Fruits and the dispersal of seeds.—The development of fruits. The various methods of seed dispersal.

Entomology and Zoology.

(1½ hours a week first year, 2½ hours a week second and third years.)

Entomology and Zoology.—1. The anatomy and morphology of a single type; internal and external, with dissection of alimentary, nervous, respiratory and excretory systems; the structure of the main tissues, working down to the cell as the unit. The aim is to give a concrete picture of the living organism as a whole, with all its activities, and to show that the tissues are themselves aggregates of living cells. The elements of animal physiology.

2. Simple types of animal life seen through the microscope, working up to more complex types. These are not treated in detail but mentioned, shown, and their characteristics briefly dealt upon.

3. The main classes of living organisms. Vertebrate, Invertebrate. Some examples of lower classes, *i.e.*, Arthopods and Molluscs. The five main classes

of Vertebrates with short treatment of their characteristics. The main classes of Mammals, with reference to domestic and noxious animals.

Agricultural entomology.—*Structure*, external and internal, of one type (*e.g.*, grass-hopper), and of insects in general, the latter broadly and not in any detail.

Life history.—Of two types (*e.g.*, butterfly and grass-hopper), in detail.

Orders of Insects, characters, life history and recognition only.

* *Families*, of economic interest, their recognition, life histories, food and general occurrence in the field.

* *Crop Pests*, treated under food plants in classes, with methods of prevention and treatment.

Useful and *Beneficial* Insects.

Biological subjects of general interest (colour, form, mimicry, evolution, insects as disease carriers, etc.,) should, if possible, be treated in lantern lectures and not as a part of the main course.

Practical work.

(1) *Field work.*—Throughout the course, the students should be shown pests in the field as they occur. Students should also be encouraged to collect, and to observe insect life in the field.

(2) *Laboratory work.*—Students pin and set what they collect and should be marked annually or each term for their collection which must be classified. They also should be given insects to place into orders or families.

(3) *Insectary.*—The students should be familiar with the work of the Insectary and be taken over the Insectary work, say, once a fortnight in the rains and once a month at other times.

Practical work should occupy two-thirds of the whole time.

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* *Note.*—These require full treatment and should occupy the greater part of the lectures.

Veterinary Science.

External anatomy.—Of the ox, the buffalo, sheep and goat. The names of different parts of the body as seen in living animals and their functions.

Internal anatomy.—(*a*) The skeleton. The names and recognition of the principal bones and joints of the above animals and their effect on the conformation.

(*b*) General sketch of the muscular system and its function.

(*c*) Parts and functions of each of the following systems—digestive, urinary, lymphatic, respiratory, circulatory and nervous. The skin, hair, horn and hoof.

Materia Medica and Pharmacy.—The method of making up and administering drenches. Demonstrations in making infusions, decoctions, powders, ointments and liniments. The names, uses and doses of simple common medicines, English and country, with their actions. The more common poisonous plants, and poisons.

Practical.—Handling of animals. Use of the clinical thermometer and taking the pulse.

Hygiene.—Sanitary location of byres, ventilation, drinking water, wholesome food, cleanliness, etc.

Medicine and Surgery.—Signs of health and disease. Names and symptoms of the more common external and internal diseases of the ox, buffalo, sheep and goat. (*Note.*—At least half this course should consist of practical demonstrations at the nearest Veterinary Hospital.)

Treatment of the simple complaints of cattle. Treatment of ordinary forms of wounds. Lameness, sprains and shoeing.

The most deadly forms of contagious disease with their chief symptoms, and sanitary measures for their suppression and control.

Obstetrics.—Normal and abnormal parturition. Its management in simple cases. (*Note.*—This course should also be practically demonstrated at the nearest Veterinary Hospital.)

Agricultural Engineering.

Mensuration.—Areas of plane surfaces, volumes of solids, regular and irregular, including capacities of tanks, ponds and wells.

Method of roughly testing discharges and ascertaining the efficiency of different means of lifting water.

Surveying.—Simple land surveying, calculation of areas; simple methods of levelling; laying out of plots.

Construction and repairs.—Knowledge of materials. Preparing rough specifications, plans and estimates of farm buildings, roads, wells, tanks and embankments.

Simple dynamics and machines.—Elementary dynamics in relation to agriculture. Principles of construction and care of implements and machines. The use of small engines.

Land Records.

The local system of land records of each province.

The Board considers that some form of degree or diploma should be conferred by provincial agricultural colleges. In view of the danger that diplomas conferred by individual colleges should have a different value, and to secure uniformity it suggests, that a combined diploma should be given and that the Government of India be moved to recognise it as equal to the B. A. degree. As regards the exact title conferred, the Board consider that some such title as Licentiate of Agriculture (L. Ag.) may suitably be given.

APPENDIX A.

CORRESPONDENCE REGARDING THE PROVISION OF A DEFINITE PLAN OF EXPERIMENTS AT PUSA.

Letter from Dr. H. H. MANN, D. Sc., Scientific Officer to the Indian Tea Association, to the Inspector General of Agriculture in India, dated Calcutta, the 6th July 1905.

It is with a good deal of diffidence that in response to your letter of February 6th, 1905 (No. C 100), I venture to suggest some lines of permanent field experimental work at the Pusa Research Farm. But it has seemed to me ever since the scheme for the Pusa Institute was initiated that there is an opportunity for doing much more fundamental work on tropical agriculture than is possible in the provincial or other experimental stations of India, or even of the United States of America. It was on this account that at the meeting of the Board of Agriculture in January, I raised the question as to whether the scheme of experiments then proposed was intended to be a foretaste of those to be undertaken under a permanent arrangement. Any suggestions, however, that I have to make must be in an absolute skeleton form, and can only deal with one aspect of what I hope may be a large and very effective permanent experimental scheme.

2. Before, however, I go on to indicate the lines I consider such permanent experiments should take, there are, it would seem, some directions which should, in large measure, be avoided.

(*a*) There will always be a tendency to make Pusa a testing ground for crops and varieties to be cultivated in Behar. Now to form such a testing ground, valuable as the idea may be, seems not to be the function of the Pusa Institute, but rather of a provincial farm. I should welcome the large extension of the provincial farm idea worked as independently as possible, as its extension will tend to remove from Pusa those local inquiries which now take up so much of the time and hamper in every direction the more general work to which the Pusa staff might devote themselves. In any case such purely local inquiry should be of an essentially subsidiary nature, and not interfere in point of time or space with the work more properly undertaken by a central station for the whole of India. In fact, it should be impressed on all in connection with the Pusa establishment that we are not there forming an experimental station for Behar, but for the whole of India.

(*b*) If the last point be granted, it will be at once seen that any testing of varieties will fall into a very subordinate place. Varietal tests are generally made in order to determine the applicability of a particular variety to special regions. Hence tests made for such purposes are as a rule out of place at Pusa. There are, of course, cases where such tests would be of extreme value, such as in the testing of what is practically a new crop, like Natal Indigo, but cases like these are exceptional.

If it is not out of place, I would go further and say that, as ordinarily carried out, varietal experiments seem to have only comparatively little value anywhere. I notice that in a recent report of the Woburn Experimental Fruit Farm* the authors (Duke of Bedford and Spencer, W. Pickering) in discussing a long series of varietal tests with strawberries take this view. My own experience with experiments on varieties of barley, wheat, oats, etc., at the Royal Agricultural Society's Experimental Farm in England has told in the same way. Unless varieties are so wide apart as to almost form agriculturally different crops, the slight variations in conditions of various plots usually more than counterbalance the influence of the special characteristics of the variety under experiment.

3. If we largely eliminate local inquiries and varietal tests, the opportunities for fundamental investigations into the nutrition of agricultural plants under tropical conditions becomes very much greater. It cannot have escaped the notice of all those who have had to deal with agriculture in India, that surprises are met with almost every day. No one has ever explained how it

* Woburn Experimental Fruit Farm, 2nd Report. Eyre and Spottiswoode, 1902.

is that the black cotton soil, not intrinsically rich, will go on producing a crop year after year apparently almost for ever, while bones added to such a soil rather diminish than increase its fertility (Nagpur Farm). The rice and jute crops grown without manure in the alluvial areas of Bengal are a perpetual source of astonishment to me, and the common explanation that this permanence is due to the fertilising value of the silt deposited thereon seems absolutely inadequate for a large portion of such areas. Judging by European standards, many of the crops would seem long ago to have reached the irreducible minimum of crop, or else to be influenced by laws in plant nutrition which differ considerably from those of temperate climates.

Further, the continuous and paying growth of a crop like tea on soils which in England would be considered as poor in the extreme is not to be entirely explained by any information we have now at hand. A recent result obtained in the West Indies showing the uselessness of phosphatic manures for sugarcane on land excessively poor in phosphoric acid is another instance in point.* Other instances could be multiplied in India and many other tropical countries, but the above are sufficient to indicate the suspicion that the laws regulating the nutrition of plants are not precisely the same in tropical as in temperate conditions.

4. I, therefore, beg to suggest that the primary and fundamental field experiments at Pusa should consist of a well organised attempt to determine the nutrient requirements of Indian crops under tropical conditions. Such experiments should be laid out to last a long time; they should be largely duplicated by pot culture experiments and even by water culture where necessary; and they should deal in the first instance with at least four crops which can be successfully grown at Pusa, three of which should be food crops, and one a crop which largely depends for its value on flavour-producing constituents, like tobacco.

In the first place it would seem to be wise to grow these as permanent crops, and as such I would suggest—

(1) a gramineous crop for the rains, say sugarcane,
(2) a gramineous crop for the cold weather, say wheat,
(3) a leguminous crop, and
(4) tobacco.

It will be noticed that under a scheme such as the above, the land would be vacant for a considerable part of the year. This time of vacancy would be exceedingly valuable from the point of view of studying the effect of one crop with or without manure on the succeeding herbage, a point which has been lost sight of in much investigation of plant nutrition. Experiments of this sort would, to obtain their full value, have to be accompanied and followed closely, as has already been noted, by pot culture and even water culture investigation if their full value is to be obtained. The advantage of doing this is well illustrated by some recent experiments made by Mazé† on the effect on the roots of plants of various methods of supplying nitrogenous food.

5. Side by side with these and of equal importance are investigations into the customary rotations of the country. Our knowledge of the meaning and value of rotation is extremely limited as some of the recent results obtained at Woburn show most conclusively.‡ On that experiment station a leguminous crop (tares) has given consistently worse results than a non-leguminous crop (mustard) when it was used as a preparation for wheat, quite contrary to all that was expected from considerations generally accepted in the scientific world.

Such experiments, which it is impossible to suggest in detail, would determine such points as—

(*a*) The best crop 'A' to precede crop 'B'.
(*b*) The length of time the advantage of using crop 'A' lasts.
(*c*) Whether the best crop 'A' to precede crop 'B' is also the same as to precede crop 'C' which may belong botanically to the same order, or not.

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* Manurial experiments with sugarcane in the Leeward Islands, West Indies Imperial Department of Agriculture, No. 36, Pamphlet Series, 1905.
† Annales de l' Institute Pasteur, 1900, p. 26, et seq.
‡ See Journal of Royal Agricultural Society of England for 1904.

(*d*) What is the nature of the action of such a crop used as a preparation for another, that is to say, is it purely mechanical (and so may be obtained by other means), partly mechanical and partly chemical, wholly chemical, or largely biological?

Such investigations as these are difficult, but then Pusa is designeed to undertake inquiries which are too difficult and too general to be tackled by any provincial farm. The results of such experiments, carried out thoroughly would not only be the most important ever obtained in India, but among the most far reaching ever carried out in the world.

6. Such fundamental experiments in plant nutrition under tropical conditions might and ought to be carried a stage further even than the above. I have suggested experiments on the nutrition of crops grown alone, and grown in rotation,—they should also be investigated when grown in association. The only experiments on these lines, that I know of, hitherto carried out anywhere are those on the association of pasture grasses and clovers, etc., at Rothamsted and similar inquiries elsewhere. While these may be taken as indicating the idea I have in view, yet far more simple cases than that there investigated lie, ready for study, in large numbers over almost the whole agricultural area of India. Various peas and dhals (*e.g.*, gram and arhar) are thus grown in the areas which have come under my observation, and this is one illustration of a practice common in Indian agriculture.

7. I have now indicated the lines of investigation which most appeal to me in connection with the subject. It has long seemed a desideratum, to have investigations made into the nutrition of plants in the tropics. Pusa affords a chance for doing this, and the work, while ultimately it will be intensely practical, yet is of such a fundamental character as to command the respect of those who look to Pusa to yield results not only applicable in practice but also which will help to found a scientific basis for the culture of the land.

Copy of a letter from Dr. A. LEHMANN, PH.D., Agricultural Chemist to the Government of Mysore, to the Inspector General of Agriculture in India, dated Bangalore, the 6th September 1905.

I have left your letter asking for suggestions in regard to experiments to be conducted at Pusa unanswered for a long time in the hope that I should be able to give, later on, the time I thought necessary to consider such an important matter.

The work Pusa will have to undertake depends, in my opinion, very largely on the work the local department of agriculture will be able to take up. Should these remain in any way as poorly supplied with specialists as they are now, work at Pusa must necessarily be of a much lower order and much more restricted in scope than if these local departments have specialists of their own. For, in my opinion, Pusa must aim to do for the local departments work which it would be impossible or very difficult for them to do themselves. To do work at Pusa which these local departments could, or should, do for themselves would, in my opinion, tend to reduce the usefulness of the local departments and thus rather tend to retard than advance agricultural investigation. It is possible, however, that notwithstanding this it might be highly desirable and stimulating to the local departments if at Pusa they could *see* experiments which they might copy on their own experimental farm. But such experiments should, in my opinion, not be considered as experiments but simply as *demonstrations* of experimental farm methods. And as accurate experiments in agriculture are, I believe, taken as a whole, as yet in their infancy in India, such demonstrations might be very desirable, if not absolutely necessary, unless local departments have at their disposal the services of experienced specialists in agricultural investigation. The chief points of such experiments should however, in my opinion, always remain demonstration and they are, therefore, notwithstanding that they may form an important part of the *work* at Pusa, removed from the *experimental* work proper and would form a part of the *educational* work. To this class of work would, in my opinion, belong variety experiments, ordinary manurial experiments, cultivation experiments, as for example deep ploughing *versus* shallow ploughing, times of sowing and

such other simple experiments which can be easily conducted on the local experimental farms and are to a large extent influenced by soil and seasons.

Indirectly I have heard that the Imperial Government is urging the local governments in a very 'substantial' way to engage their own chemist, botanist and entomologist, or such other specialists as may be considered most urgently required. I sincerely hope that this is really the case, and if so, I believe that a very important part of the experiments at Pusa should be :—

(1) To investigate methods of work and revise standards for experimental work adapted to Indian conditions. For example, to test by way of pot cultures or otherwise in how far the figures given by Dr. Bernard Dyer for available potash and phosphoric acid would apply to Indian soils or how the appliances for conducting pot culture experiments must be modified to make this important line of investigation possible in a tropical climate.

(2) To conduct investigations which are not of a local nature and help to solve some general problems of Indian Agriculture. As samples of this might be given :—(*a*) the rate of evaporation from different soils under various conditions, the effect of a mulch and of green manuring on soil moisture, the amount of soil moisture required per pound of dry matter produced to give maximum yields of crops of various kinds ; (*b*) to study what effect the crust on the surface of the soil has on the growth of plants; to what the excessive crust formation in parts of India is due ; if the laterite plays any part in this, and if so, is it simply a mechanical effect or partially due to chemical causes; and how can this crust formation be most effectively overcome; (*c*) the effect which the high percentage of iron in many soils has on the available plant food, especially phosphoric acid in the form of soluble phosphates, and what manurial value may be attached to phosphate of iron which is generally believed to be valueless, but which, according to recent experiments conducted in Japan, has given good results when applied to paddy on a soil rich in humus.

In making these suggestions, I have only considered the subject of agricultural chemistry. With the various branches of botany and entomology, I am not sufficiently acquainted to offer any suggestions as to where the line between the work done at Pusa and at the laboratories of the local departments of agriculture might be drawn.

Copy of a letter from CAPTAIN *A. T. GAGE, I.M.S., Superintendent, Royal Botanic Garden, Calcutta, to the Inspector General of Agriculture, dated Calcutta, the 7th September 1905.*

With reference to your letter No. C. 98, dated $\frac{6th}{17th}$ February 1905, I have the honour to offer the following suggestion which very probably has already been thought of.

A considerable amount of attention has been given for many years by various men to the fibre-yielding plants of India, but even now it is difficult to say of almost any part of India which particular kind of fibre-yielding plant it pays best to cultivate. Some have devoted themselves to Sisal, others to Rhea, others to Sansiviera cultivation, but a systematic comparative investigation of fibre-yielding plants generally from the different aspects of ease of cultivation, time within which fibre is yielded, readiness of its extraction, market value in its prepared state, etc., has not yet been carried out in India, Royle's "Fibrous Plants of India," 1855, being the nearest approach to such.

I would suggest that a fibre plantation of a permanent character be started at Pusa, on a sufficiently large scale to allow of reliable results being obtained from the comparative investigation of the chief fibre-yielding plants capable of growing in the climate of North Bengal. Subsidiary to the plantation, there would be decorticating machinery and the other necessary means of preparing the fibres for the market and of testing the strength of the different kinds. In such a plantation would be cultivated, the various kinds of Agaves found in India and elsewhere—for it is by no means certain that Sisal hemp is the only or even the best fibre-yielding species of Agave that can be grown in India— the various species of Furcræa, of Sansiviera, of Musa and such plants as Alpinia, Hemp, Flax, Jute, Sunn Hemp, Abroma, Rhea, Villebrunea and others I need not here particularize.

Copy of a letter from G. A. Gammie, Esq., F.L.S., Economic Botanist, Bombay, to the Director of Land Records and Agriculture, Bombay, dated Kirkee, the 29th April 1905.

With reference to the enquiry contained in your No. A—2072 of 25th March 1905, I have the honour to make the following suggestions (from the point of view of a Botanist only) as regards experiments which I consider desirable in the permanent scheme of experiments for the Pusa Research Institute. It is very necessary that a complete census of all the agricultural plants of India (based on the examination of living examples only) should be undertaken without delay, as the enquiry, no matter how rapidly and efficiently it is conducted by provincial officers, will probably require several years for its completion.

The cottons, wheats, etc., have been dealt with in a way, but much remains to be effected in the shape of exact details by provincial officers.

Systematic Botanists have, as a rule, ignored the claims of Agricultural Botany and the consequence is that there is not even a moderately good hand-book on the crops of the whole of India, although it is a subject of such great importance.

To attempt to gather materials for a complete census at Pusa for the present is unwise, but there is no reason why a start should not be made with Behar or Bengal plants.

Before we attempt the improvement of any kind of crop whatsoever, we ought to be in a position to know exactly how many varieties may be in the country and also their comparative qualities. These schemes for improvement, if found to be actually necessary, could then be drawn out with some degree of certainty.

APPENDIX B.

NOTES ON THE IMPROVEMENT OF INDIAN WHEATS.

SYNOPSIS.

1. *Varieties of Indian wheats.*—A beginning has already been made in the study of the chief types cultivated in the principal wheat-growing districts of India, but the work is not yet complete. It is evident that a survey of Indian wheats in each province must be completed before the question of wheat improvement can be taken up. The general agricultural characters, distribution and the suitability of the grain for local use or export must be known before the wheat question can be seriously approached. A classification of Indian wheats from the standpoint of Systematic Botany only, although of some interest, will not be sufficient. It will be necessary to approach the subject from a broader point of view and to take into consideration the agricultural aspect of the question as well.

The whole subject is complicated by the fact that the amount of wheat exported is only a small proportion of that grown and further that the varieties sent to Europe are not always those in greatest local demand. Excluding Macaroni wheats, the soft white types are chiefly exported, while the harder forms are preferred for consumption in India. It is possible, therefore, that the requirements of England may lead to the cultivation of special types for export; and already this separation appears to be beginning as the varieties most largely exported in the Central Provinces, United Provinces and Bengal belong to the soft white group. The shipments of Macaroni wheats from India are said to have fallen off of late. Further information on this point seems very desirable.

The production of rust-resisting varieties seems most urgent in the Central Provinces, in Bengal and Bombay and in the United Provinces (except in the north and west). In the Punjab and in the north-west districts of the United Provinces, rust does not seem to be so important a factor.

2. *Uniformity of sample and source of seed for sowing.*—The advantages in growing the various varieties unmixed are evident, whether for export or local use. It appears that the best cultivators in all the Provinces generally do their best to keep the varieties pure and also save their own seed. The poorer cultivators, on the other hand, buy seed from the local grain dealer and thus often sow mixed wheats of poor quality. In the Bundelkhand Districts of the United Provinces it is usual to mix varieties as a form of insurance against accidents of season, but the exact nature of the mixtures preferred has not yet been ascertained with precision.

3. *Rotations of wheat land.*—The rotations of wheat land in the various districts of India vary greatly. The practice of growing leguminous crops in connection with wheat is almost universal in the Central and United Provinces and in Bengal. In the Punjab and in the Bombay Presidency, on the other hand, leguminous crops practically disappear in the rotation and wheat is either grown continuously, with or without a fallow, or in a rotation comprising other cereals (millets or maize) or cotton, with an occasional fallow.

4. *Adulteration.*—It is clear that the large proportion of foreign matter in wheat exported from India is not due to the processes of winnowing and threshing but to adulteration by dealers and middlemen. The impurities connected with threshing do not greatly exceed one per cent. while the average refraction seems to be about five per cent. It appears that the custom of adding earth, etc., is due to the fact that exporters buy on the assumption that the impurities reach a certain percentage. Although this question is, strictly speaking, outside the province of agriculture, it nevertheless has an important bearing on the cultivation of wheat in India. The practice of watering the sample before export, so as to increase the weight, is only mentioned in the Punjab Report.

5. *Production and export.*—The production and export of the chief wheat-growing provinces is shown in the following table:—

Year.	Punjab.			United Provinces.			Central Provinces.			Bengal.
	Production.	Export.	Percentage exported.	Production.	Export	Percentage exported.	Production.	Export	Percentage exported	Production.
	Tons	Tons.		Tons.	Tons		Tons.	Tons.		Tons
1900-01 .	2,636,683	623,982	23	2,436,815	377,630	15	440,909	15,403	3	472,000
1901-02 .	1,816,332	535,823	29	2 411,111	86,195	4	671,010	33,925	6	391,500
1902-03 .	2,314,714	876,127	37	2,428,629	324,037	13	666,589	72,892	11	485,000
1903 04 .	3,070,161	1,190,603	38	3,005,518	532,926	18	751,388	157,577	21	527,800
1904-05 .	2,855,753	...	...	3,265,389	814,000	25	760,647	141,462	19	444,100

6. *Damage by weevils.*—Grain stored for local consumption and sowing suffers more from weevils than that exported as most of the latter is moved before the rains. The damage done appears to be connected with the amount of moisture present and is considerable during the rains. The old practice of storing wheat in pits which appears to be general in India is, in the Punjab and Sind, giving place to house storage. Here the grain is kept in a well-ventilated room with burnt brick walls and floor, with wheat chaff at the top and bottom of the heap, the walls being lined with grass matting. No special precautions appear to be taken to prevent damage by weevils and no mention is made of the use of carbon bisulphide in freeing wheat from these pests. The matter of wheat storage in India, therefore, appears to be worthy of attention.

7. *Ports of shipment for exported wheats.*—The exports of the Punjab and Sind and about 18 per cent. of that of the United Provinces are sent *viâ* Karachi. The produce of Bengal and 67 per cent. of that of the United Provinces goes to Calcutta as well as a portion of that grown in the Central Provinces. The remainder of the wheat exported from the Central Provinces and about 15 per cent. of that of the United Provinces is sent to Bombay. The total volume of the export trade in wheat of Calcutta is given as one and a half million tons. That of Bombay and Karachi is not given.

8. *Experiments on wheat improvement.*—Wheat experiments are being carried out at the Experimental Farms in all the wheat-growing provinces. In the Punjab, 50 acres are devoted to wheat at the Lyallpur Farm and 250 acres at the seed distribution farm at Sargodha. In the United Provinces there are wheat experiments at the Cawnpore Farm and at Orai in Bundelkhand. In the Central Provinces there are experiments at Nagpur (7 acres), Hoshangabad (25 acres) and at Raipur (3½ acres). In Bombay there are experiments in progress at Poona and Manjri, at Mirpurkhas (15 acres) and at the Dharwar and Dhulia Farms. In Bengal there are trials at Dumraon (4 acres) and at the Sripur Farm.

(*a*) *General nature of the experiments.*—The wheat experiments at the various Experimental Farms are of the same general character. Varietal, selection (both as regards yield and rust-resisting power), hybridization and manurial experiments are generally mentioned. At Cawnpore, the experiments are designed for a special object—the production of a wheat suitable for the Bundelkhand Districts. Rotation and tillage experiments are also being conducted in the Central Provinces. At the Poona and Manjri Farms, Professor Gammie has made a provisional botanical classification of the Indian wheats cultivated there. Australian varieties have been largely tested at all the Experimental Farms.

(*b*) *General results of the wheat experiments.*—The introduction of exotic varieties has not been very successful. Prospects are said

to be hopeful, however, in the case of Australian No. 27 at the Lyallpur Farm in the Punjab. In other directions the results have been more encouraging. Thus, in the Central Provinces, a hybrid produced by crossing a hard white (Haura) with a soft red (Mundia) wheat has been found to be the most rust-resistant, and seed is distributed every year to cultivators through the Agricultural Associations. Muzaffarnagar wheat has been distributed from the Dumraon Farm in Bengal and has remained true to type and given encouraging results. Both in Bengal and the Punjab, however, this variety suffered from the severe cold of last winter. It is said that all soft wheats introduced at the Poona and Manjri Farms show a strong tendency to become hard.

(*c*) *Distribution of seed to cultivators.*—The distribution of seed, where this has been done, is carried out largely by means of the Revenue Officers. In the Central Provinces, Revenue Officers, Members of the Agricultural Associations, Deputy Commissioners and Agricultural Experts watch the results as far as possible and they are discussed at the meetings of District Agricultural and Industrial Associations. In Bengal seed is distributed to the ryots through Collectors and Managers of Wards Estates. In the Punjab, the varieties are observed for several years on the Lyallpur Farm and a preliminary issue is made to selected men who report on the results.

(*d*) *Publication of results.*—The results of the wheat experiments are published in the Reports of the Government farms in English. In the Central Provinces leaflets in Hindi and Marathi are issued in addition.

A. HOWARD,

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Fungus diseases of wheat.

(*1*) *Rust.*

I. *The incidence of rust in the chief wheat districts.*—Of all the conditions which govern the extension of wheat in any province the incidence of rust is probably the chief. The crop is a popular and a paying one in the great dry area of the North-West and the way seems to be clear for a large extension hand in hand with the extension of irrigation in this region. The incidence of rust is slight in the Punjab, North-West Frontier Province and Sind; total loss from this cause is unknown and the average annual loss is not considerable. But a danger lies in the very extension of irrigation which has permitted of the recent large increase of the area sown to wheat in these provinces. The Punjab owes its comparative immunity to rust to its dry climate and soil. I know little of the influence of canal irrigation on climate but sufficient is known of its effects on soil to indicate that there is a probability of a large increase of the disease brought about by frequent heavy floodings of the irrigated tracts. It is a subject for inquiry by the local department how far this is occurring or has actually occurred, since this will influence the lines on which the efforts should be made to introduce improved wheats into cultivation. At present the requirements of the Punjab appear to be primarily improved drought-resistant wheats but the time may not be far distant when the demand for rust resistant sorts will become as great as in other less favoured provinces.

In Central India, Bundelkhand and the adjoining parts of the United Provinces, the Central Provinces and Berars, the severity of the disease is much greater. It is in these areas that the enormous losses which have been recorded from time to time in the Indian wheat crop have chiefly occurred. In Bundelkhand drought-resistance and rust-resistance are of almost equal

importance, and the possibility of combining these two qualities has been kept in view in the production of improved wheats intended for these areas by the Department of Agriculture of the United Provinces. In the other wheat growing tracts of Central India, the development of the quality of rust-resistance is the object chiefly to be aimed at.

In the east of the United Provinces, in Behar and in Bengal proper, drought-resistance is of comparatively little importance. But the steady annual loss from rust in these districts, although rarely reaching to an actual calamity, is enormous and the need for good rust-resistant wheats is very great.

I have little actual experience of the requirements of Bombay in regard to the disease, and know nothing of the condition of the small wheat crop of Madras except that it also suffers from rust.

II. *The extent of the loss.*—Any attempt to estimate the annual losses from this disease must necessarily be of the crudest nature. The triangular area enclosed by lines uniting Bombay, Simla and Calcutta includes the greater part of the wheat growing provinces liable to rust. The total production of wheat in this area in 1904-1905 was over 4½ million tons of a value of nearly 300 millions of rupees. If we take the average loss owing to rust at 10 per cent. (it largely exceeded this figure over a great part of the country last year) we get an annual loss of about 2 millions sterling yearly from this source. I believe with Sir George Watt that this figure is too low, for the loss in weight of grain in rusted plants when tested by actual weighing is much greater than appears on the surface, reaching from two-thirds to five-sixths in bad cases.

III. *The causes of the disease.*—Three different fungi are concerned in this disease. Sometimes, one only is present. More often two combine to attack the one plant. It is not infrequent to find all three together. They are known respectively as *Puccinia graminis* or black rust, *Puccinia glumarum* or yellow rust, and *Puccinia triticina* or orange rust. The areas of their respective distribution do not exactly coincide. Thus orange rust is far more prevalent in the east and black rust in the south of the triangle above referred to. A technical description of the three rusts has been drawn up and illustrated by coloured figures but though submitted for publication about fourteen months ago it has not yet appeared. The need for those in whose hands the work of introducing improved wheats into India lies, being in a position to identify the different species of rust, arises from the fact that the resistance of a plant to one rust does not necessarily imply resistance to the others. To introduce a rust-resisting wheat from the Central Provinces where it has been exposed to the attacks of yellow and black rust into Bengal where it has to face orange rust, would be to court failure. It is necessary that the resistance of each wheat should be tested in regard to the species of rust which it has to meet in actual cultivation. Another and still stronger reason why each wheat growing area must work out its own salvation lies in the fact that the quality of resistance is often lost on transference to a new climate. We have numbers of instances of this having actually occurred.

IV. *Measures proposed for dealing with the disease.*—In a note submitted to the Board of Agriculture last year, proposals were made for definite work in the selection of rust-resisting varieties in certain localities. The recent provision for expert supervision in most of the provinces will admit of this subject being taken up on much broader lines than are there indicated. It has recently been shown that resistance to rust in hybrids obtained by crossing rust-liable and rust-resistant varieties is what is known as a recessive hereditary character, and as such the resistant progeny tend to preserve the character and to transmit it unaltered under normal conditions. With the actual work in producing rust-resistant wheats either by selection from existing varieties or by hybridization, I am not concerned, for such work now falls into the province of other scientific workers already engaged or about to be engaged by the different provinces. But we are fortunately in a position now in which we did not find ourselves last year, to attempt to deal with the question on definite lines scientifically controlled, and I would urge that the production of rust-resistant wheats should be given a prominent place in the scientific programmes of the provinces concerned.

(2) *Smut.*

Smut in wheat does not, in any locality with which I am acquainted, reach such a degree of severity as to render any organised attempt at control necessary. It can easily be checked by seed treatment at a small cost, and this has already been demonstrated on several of the Experimental Farms. But nowhere so far as I know does it affect the crop to such an extent as to justify the taking of special steps to disseminate information or to demonstrate the treatment to cultivators in the same way as the similar diseases of juar and oats.

The cause is a fungus, *Ustilago Tritici*, whose spores adhere to the seed coats of the grain and germinate when the latter is sown, thereby giving rise to infection of the young shoot. The subsequent appearance of the disease in the ears is due to growth of the fungus within the growing plant and maturation only when the ear commences to form. The adhering spores on the seed coats may be destroyed by steeping the seed in various solutions of which the most effective and simplest are solutions of one-half per cent. copper sulphate and 1 per cent. formaldehyde.

(3) *Mildew.*

Mildew, caused by the fungus *Erysiphe graminis*, is common in some parts of India. It does not however usually cause any considerable damage and its successful treatment is so expensive that it is never likely to come into actual practice.

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Insect Pests of Wheat.

Wheat is subject to the attack of four pests—

(1) Surface Weevil (*Tanymecus indicus des. Log.*).

(2) Termites (*Termes Taprobanes. Hag.*).

(3) Wheat Stem Borer (*Nonagria uniformis. Ddgn.*).

(4) Wheat aphis (*Siphonophora Sp.*).

1. In many districts, the germinating wheat is successively destroyed by the small grey-brown weevils, which live on the surface of the soil, feeding upon the delicate shoots as they come out of the ground. No other food being available, the weevils, if plentiful, eat off the entire crop; a fresh sowing is made which is again eaten off and several sowings may be necessary before the crop is established.

The life history of this pest is not passed in wheat but in some wild plant, and until this has been worked out, no general measures are possible to check the pest.

The preventive measure likely to give the best results is to provide the weevils with other food; if it be possible to sow a small quantity of another plant with or before the wheat, scattered over the fields, the weevils will be less destructive to the wheat; the same result is obtained by placing heaps of cut grass or green vegetation, branches of green trees or even chips of pumpkin over the fields, the weevils collecting there to feed and being readily destroyed.

2. Termites are injurious principally to young wheat, destroying the roots of the plants. They are a recognised pest to growing plants in India and there is no special feature about their attack on wheat. No direct means are likely to be of avail that are within the reach of the ryot and the only preventive known is thorough tillage before sowing the wheat; in some cases it is possible to trace the nest and destroy it by digging it out or by watering it with hot water.

3. Wheat stem borer is a caterpillar which is found boring out the main stem; the upper part of the plant withers and, if young enough, the plant throws out side shoots to replace the main one. The main stem

is wholly destroyed and withers, the loss being a considerable one only when the grain is forming and the new shoots are not formed. There is no direct remedy for this pest in wheat except the destruction of the withered stems that contain the borer, and which are readily seen. As with many other pests, the cultivator has a remedy in his hands that is merely a matter of ordinary common sense, but it is unlikely that he can be induced to adopt it.

4. Wheat is also infested by a green aphis, similar in general to other aphides that attack other staple crops. It appears on the young plant, feeds on the leaves, multiplies and when the ear forms, gathers in it and sucks out the seeds. Each ear may contain many insects, sucking out the juice; the grain formed is light and of poor quality, the yield being materially reduced. Aphis is readily checked if taken in time, but the cultivator is not likely to search out the first colonies and destroy them until some elementary ideas of the nature of insect life have been instilled into him.

Further investigation is required to elucidate the habitat of the wheat aphis when wheat is not growing; this will probably prove to be the *crux* of the whole matter, but the problem is a difficult one not likely to be immediately solved. This investigation is in progress in the insectary and the wheat aphis will probably be susceptible to preventive treatment when this point has been worked out.

On the whole, wheat suffers more largely from the surface weevil than from other pests; the distribution of aphis and of stem borer is probably local, and the termite does not appear to be a widespread pest in this crop. In some parts of India, the cultivator already checks the weevil by the use of a trap crop or by placing chips of pumpkin in the fields and there is probably no reason why, under the guidance of trained Entomological assistants, this pest should not be destroyed more generally.

The Grain Weevil.

The problem of checking the ravages of weevils in grain is not one that can be dealt with in a short space. The conditions under which wheat is stored in different tracts of India, the transport and storage of wheat in bulk and its treatment in large quantities at ports, offer so many varied conditions that no single method will be of any avail. No progress can be made with this problem until full inquiry is made by an expert who can devote his whole time to investigation not only into local conditions in the important areas, but also at ports of shipment and in large towns where grain is held in bulk. Nothing short of a thorough and prolonged investigation will be of material use, and it is a waste of time to suggest any methods not based on this investigation.

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Bombay.

1. *Varieties of Indian wheats.*—All that are known to me are given in my provisional classification of the Indian wheats cultivated at the Poona and Manjri Farms.

Soft white wheats.—I have a record of one variety only in the Bombay Presidency (proper), namely from Nasik.

Hard white wheats.—There is one variety of beardless wheat from Nasik with hard white grains. A number of the Kalakusal or Bakshi wheats are hard white, as are also a number of the Popatia wheats. The Kalakusal wheats of the Deccan and the Hansiah of Broach are said to be the finest in the Presidency; they are grown as dry-crops on retentive soils. They are very liable to rust and are considered delicate crops.

Soft red wheats.—I believe there are none in the Presidency.

Hard red wheats.—Khapli is hard red. There are a number of varieties of the Kalakusal and Popatia types, and two at least of Daudkhani wheats.

2. I think that in the Bombay Presidency the varieties grown are of distinct types and that mixture rarely occurs.

3. The ryot as a rule probably saves his own seed.

4. "Dry-crop wheat is grown continuously in some parts of Ahmednagar, Ahmedabad and Nasik. In the cotton districts of Khandesh, Dharwar, Broach, etc., it is rotated with cotton and jowar. In the deep black soil which borders the Tapti in Khandesh it is rotated with linseed and gram. In the Panch, Mahals on land brought under tillage, during recent years, it follows a kharif crop of maize, the land being double cropped annually. This is an exhaustive system of cropping which can only be practised in virgin land. Irrigated wheat is rotated with ordinary garden crops but no definite order is followed" (Mollison).

5. I am informed by Messrs. Ralli Brothers that foreign matters in Indian wheat are greatly due to the mode of threshing.

6. The percentage of foreign matter in exported wheats greatly depends on the basis on which wheat is sold to Europe. It generally varies from 3 to 4½ per cent. in wheat exported from Bombay—(Ralli Brothers).

7. The information from the Chamber of Commerce has not yet been received.

8. Damage to wheat by weevils is considerable, especially after the rainy season, whether the wheat be for export or for local consumption; we believe, however, that after a parcel has been passed through winnowing machines and exported, the said exported parcel suffers less than a similar one kept in the country. Sometimes wheat is stored before the monsoon in well-closed pits, in which case it does not get weevilled; in other directions nothing is done to prevent the damage through weevils, nor have we heard of any practicable way of preserving wheat from getting weevilled; if there be any means or methods of combating this scourge they should be made public at once for the general benefit of the country—(Ralli Brothers).

9. The ports of shipment for exported wheats are Calcutta, Bombay, Karachi.

10. A number of representative wheats were brought together by Mr. Mollison for purposes of botanical identification on the Poona and Manjri Farms. I supplied the provisional classification of these in 1903 and the investigation is still in progress, but on a smaller scale, as from 1904 the experiments have been conducted on a selected number of farms. No one variety has been cultivated on a sufficiently large scale to test its outturn, and the cultivation has been controlled by irrigation. From the first, grains have only been collected from the most vigorous plants. On the whole there has been a steady improvement in growth, probably also in the outturn, as the average weight of grains on the whole increases slowly and steadily year by year. Strict attention has also been paid to the selection of seeds from plants freest of rust. It is too early yet to make a definite statement, but the plants seem yearly to become more resistant to rust. Smut is easily checked by steeping the grain before sowing. Experiments have also been conducted in hybridization of wheats. There seems to be no difficulty in establishing an intermediate race in two years. Samples of these hybrid wheats have been sent for valuation and the report will be despatched as soon as it is received. Some forms of hybrids, and notably one resembling the branched or mummy wheat, seem to be incapable of perpetuating their characters beyond the first year. Those which partake of the mingled character of the two parents are of an easily fixed type. Wheats are normally self-fertilized and I have never observed an instance of natural hybridization, and no hybrid can be exactly matched with a cultivated race. As regards results of introducing new varieties, we find that in the soil of the Poona and Manjri Farms, all soft wheats show a strong tendency to become hard; and the writer shares the opinion of Mr. Ozanne, that improvement in wheat cultivation cannot be expected from the use of imported seed and that the wheats of each district will show what is best suited. Mr. Ozanne states that after the famine Jubbulpore *Pissi* wheat, a soft white, was sown in Athni sub-division of Belgaum. It rapidly degenerated to a hard red. *Kanur pathar*, dry crop *Bakshi*, a celebrated variety from an elevated portion of the Parner sub-division of Ahmednagar, was sown by two good farmers in Newasa in dry-crop land, in two years it became so like the ordinary *Shet Gahu* that it could not be distinguished from it. In certain Parner villages, especially in Brahmangaon, the *pivla* wheat keeps its colour and other characteristics. This sown in Newasa in two years degenerated into *Kalegahu*. The new

improved and introduced varieties have not been produced in sufficient quanti ties to allow of the distribution to cultivators. Before this distribution can b effected, special wheat farms would be necessary. There is, therefore, no contro or inspection of the crops raised by cultivators from distributed seed. Austra lian and other wheats, introduced into India, have not been adopted by culti vators in the Bombay Presidency. The majority of the wheats grown in th Presidency seem to be peculiar to it and even wheats from the adjoining pro vinces of India do not seem to be taken up. The only observed exception t this is that the *Jonaria* wheat of the Central Provinces has appeared in culti vation in the Ahmednagar District.

11. In the final memorandum on the wheat crop of the season 1904-05 by the Director, Land Records and Agriculture, Bombay, the total outturn of wheat is said to be 469,000 tons from an area of 26¼ lakhs of acres— decrease as compared with the previous year's crop in area of 135,000 acre or about 5 per cent. and in outturn of 293,000 tons or nearly 39 per cent. Ou of the total area sown in the Presidency proper, 277,000 acres (132,00 acres in the British Districts and the rest in Native States), 13·1 per cent. wer assisted by irrigation. Of this 58 per cent. was in Gujarat, 39 per cent. in th Deccan and only 3 per cent. in the Karnatak. The whole of the crop in Kair and Cutch and ⅔rds in Sholapur was helped by irrigation. Of the total outturn 36 per cent. was produced in Gujarat, 29 per cent. in the Deccan, 9 per cent in the Karnatak and 26 per cent. in Sind. The following statement compare the area under wheat with gross area cropped in the British Districts during the 10 years preceding the famine and the subsequent years :—

Year.	Gross area cropped.	Percentage of gross to average cropped area.	Area under wheat.	Percentage of wheat t gross area
	Acres.		Acres.	
Average of 10 years ending 1895-1896	28,000,000	100·0	2,300,000	8·3
„ „ „ „ 1896-1897	23,300,000	83·1	1,400,000	6·1
„ „ „ „ 1897-1898	28,300,000	101·1	1,900,000	6·9
„ „ „ „ 1898-1899	27,900,000	99·7	2,200,000	7·8
„ „ „ „ 1899-1900	22,500,000	80·6	1,100,000	5·1
„ „ „ „ 1900-1901	25,400,000	90·8	1,400,000	5 5
„ „ „ „ 1901-1902	27,000,000	96·5	1,600,000	5·9
„ „ „ „ 1902-1903	27,800,000	99·3	1,550,000	5·6
„ „ „ „ 1903-1904	28,300,000	101·1	2,100,000	7·4
„ „ „ „ 1904-1905	Not available.		2,091,000	...

Appendix A.—Details of the wheats grown at Poona and Manjri.

Appendix B.—Extracts relating to wheat cultivation in the Bombay Presidency from th Gazetteer Volumes.

Appendix C.—Map of the wheat districts in the Bombay Presidency.

Districts with 10 per cent. or over of the total area growing wheat—red.
Do. 5 to 10 per cent. do. do. blue.
Do. 1 to 5 per cent. do. do. yellow.
Unspecified tracts— green.

Numbers—

1. Section I sub-section A of my notes on classification of Indian wheats.
2. „ „ „ B „ „
3. „ II „ A „ „
4. „ „ „ B „ „
5. „ III „ A „ „
6. „ „ „ B „ „
7. „ IV „ A „ „
8. „ „ „ B „ „
9. „ „ „ C „ „

10. Section IV sub-section D of my notes on classification of Indian wheats.
11. „ V „ A „ „
12. „ „ „ B „ „
13. „ „ „ C „ „
14. „ VI
15. Undetermined H. W. varieties.
16. Do. H. R. do.

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Economic Botanist, Bombay.

APPENDIX

Details of the wheats grown at

No.	Names of varieties	Turned into.		Dates of sowing.		Dates of reaping.	
		1902-03.	1903-04.	1902-03.	1903-04.	1902-03.	1903-04.
							SECTION I—Beardless Wheats
	Sub-section A (a).				*Spikes rather long, either altogether beardless or with*		
6	Kang of Muzaffergarh . S.W	H. W. .	H. W. .	11th October 1902.	10th October 1903.	10th March 1903.	8th March 1904 .
24	Rodi Koni of Rawalpindi „	Do. .	Do. .	Do. .	Do. .	Do. .	Do . .
35	Safed of Multan . . „	S. W. .	Do. .	23rd October 1902.	Do. .	Do .	Do. . .
36	Rodi Koni of Rawalpindi „	H. W. .	Do. .	Do. .	Do. .	Do. .	12th March 1904 .
15	Pivla Pote of Malegaon . „	Semi H. W.	Semi H. W.	Do. .	Do. .	Do .	28th February 1904
	Sub-section A (b).						
18	Lal Ferozpure . . H. W.	H. W. .	H. W. .	11th October 1902.	10th October 1903.	20th March 1903.	6th March 1904 .
25	Koni Ghori of Chakwal . „	Do. .	Do. .	Do. .	Do. .	Do. .	8th March 1904 .
26	Rangrib of Kangra . „	Do .	Do. .	Do. .	Do. .	Do. .	6th March 1904 .
28	Paman Muzaffargarh . „	Do. .	Do .	Do. .	Do. .	Do. .	8th March 1904 .
39	Koni of Jhelum . . „	Do. .	Do. .	Do. .	Do. .	Do. .	Do. .
5	Mundi, Cawnpore . „	Do. .	Do. .	18th October 1902.	Do. .	10th March 1903.	18th February 1904
7	Mundi white, Partabgarh „	Do. .	Semi H. W.	Do. .	Do. .	Do. .	Do . .
6	Pivla Botaka, Baglan, „ Nasik.	Do. .	Do. .	23rd October 1902.	Do .	Do. .	28th February 1904
	Sub-section B (a).						
4	Dagar of Pind Dadan- S. W. khan.	S. W. .	.....	11th October 1902.	10th October 1903.	Failed . .	Failed. .
7	Rati of Muzaffergarh . „	H. W. .	H. W. .	Do. .	Do. .	10th March 1903.	12th March 1904 .
16	Safed of Multan . . „	Do. .	Do. .	Do. .	Do. .	Do .	Do. .
17	Deshi of Dehra Ghazi- „ khan.	Do. .	Do. .	Do. .	Do. .	Do. .	8th March 1904
33	Safed of Hoshiarpur . „	Do .	Do. .	23rd October 1902.	Do. .	Do. .	6th March 1904 .
	Sub-section B (b).						
5	Lahore Safed . . H. W.	H W. .	H. W. .	11th October 1902.	10th October 1903.	20th March 1903.	6th March 1904
9	Ghori of Gujarat . . „	Do. .	Do. .	Do. .	Do. .	10th March 1903.	2nd March 1904
15	Ghori Chimist . . „	Do. .	Do. .	Do. .	Do. .	20th March 1903.	Do. .
22	Sathia of Multan . . „	Do. .	Do.	Do .	Do. .	Do. .	8th March 1904
23	Rodi of Attock . . „	Do. .	Semi H. W.	Do. .	Do. .	Do .	12th March 1904
24	Kankar of Dasuya . „	Do .	H. W. .	Do. .	Do. .	Do .	8th March 1904
30	Ghoni of Sialkot . . „	Do. .	Do. .	Do. .	Do. .	23rd March 1903.	2nd March 1904
31	Ghoni of Balalu Guru- „ daspur.	Do. .	Do. .	Do. .	Do. .	Do. .	6th March 1904
32	Safed of Hoshiarpur . „	Do. .	Do. .	Do. .	Do. .	Do. .	2nd March 1904
33	Rodi of Muzaffarpur . „	Do. .	Do. .	Do .	Do. .	Do. .	12th March 1904
35	Mundi of Jalandar . „	Do. .	Do. .	Do .	Do. .	Do. .	8th March 1904
37	Kankar of Gurudaspur . „	Do .	Do. .	Do .	Do. .	Do .	Do. .
38	Mundi of Karnal . „	Do .	Do. .	Do .	Do. .	Do. .	Do. .
40	Wadanak of Hoshiarpur „	Do .	Do. .	Do .	Do. .	Do. .	Do. .
	Australian Wheats.						
19	Australian Wheat 3/20. S. W.	H. W. .	H. W. .	18th October 1902	10th, October 1903.	10th March 1903.	6th March 1904
20	Do. 21/20 „	Do. .	Do. .	Do .	Do. .	Do. .	28th February . .
21	Do. 13/32 „	Do .	Do. .	Do. .	Do. .	Do. .	Do .
22	Do. 28/32 „	S W. .	Do. .	Do. .	Do. .	Do. .	Do. .
23	Do. 29/32 „	H. W. .	Do. .	Do. .	Do. .	Do. .	Do. .
28	Do. 26 . „	S W. .	Semi S. W.	23rd October 1902	Do. .	Do. .	3rd March 1904
29	Do. 27 . „	Do. .	Do. .	Do .	Do. .	Do. .	Do. .
31	Do. 46 . „	H. W. .	H. W. .	Do .	Do. .	Do. .	8th March 1904
32	Do. 56 . „	S. W. .	Do. .	Do. .	Do, .	Do. .	15th March 1904
24	Do. No. 1. H W.	H. W. .	Do. .	Do. .	Do .	Do. .	3rd March 1904
25	Do. No. 34. „	Do. .	Do. .	Do. .	Do. .	Do. .	8th March 1904

Poona and Manjri

Spikelets, 1903.			Spikelets, 1904.			Spikelets, 1905.			Grains per tola.				Rema
Average.	Highest.	Lowest	Average.	Highest.	Lowest	Average.	Highest	Lowest	1901-02	1902-03.	1903 04	1904-05.	
(*Triticum Hybernum*).													
very short awns. (*The Australian wheats come here*).													
18	22	10	16	26	12	...	...	...	...	453	324	...	
20	22	10	21	27	11	...	...	...	...	358	369	...	
20	24	10	23	29	15	...	...	...	...	389	396	...	
20	26	12	23	26	18	...	...	...	...	389	347	...	
18	22	10	19	24	13	...	...	...	...	374	320	311	
16	24	8	18	24	13	...	...	...	...	371	295	...	
20	26	10	18	25	9	...	...	...	...	356	356	...	
18	24	10	18	25	12	...	...	...	...	343	293	289	
16	26	10	23	28	16	...	...	...	...	368	373	...	
16	22	10	21	26	14	...	...	...	...	385	338	290	
18	22	8	18	22	11	...	...	...	..	352	338	...	
18	22	10	18	23	15	...	...	...	...	470	341	...	
18	22	8	18	22	14	...	...	...	...	408	305	332	
...	...	..	...	...	...	...	...	...	...	...	...	...	
18	26	12	23	28	18	...	...	...	...	430	360	...	
20	26	10	23	27	17	...	...	...	...	357	483	...	
20	24	12	22	26	14	...	...	...	...	319	416	...	
20	24	10	21	27	16	...	...	...	...	349	335	266	
20	24	10	23	27	18	...	...	...	...	336	345	...	
18	22	10	20	25	15	...	...	...	...	388	373	..	
16	20	10	20	26	15	...	..	...	...	370	337	...	
14	24	8	21	24	11	.	...	...	...	380	318	...	
16	24	8	19	26	11	...	...	..	...	402	310	...	
18	24	10	22	28	15	.	..	...	..	326	261	.	
18	24	10	22	26	14	...	...	...	.	334	291	300	
16	20	10	21	27	15	...	...	...	...	326	262	...	
16	20	8	20	25	15	...	...	...	...	355	376	...	
18	22	8	22	30	15	...	. .	...	...	374	414	...	
18	24	10	23	26	18	..	...	...	...	360	335	...	
18	22	10	21	25	13	...	...	...	..	347	285	...	
16	22	10	25	28	14	...	..	...	...	332	307	...	
18	24	12	23	28	16	...	..	...	..	360	312	...	
20	24	12	21	26	16	20	24	14	...	375	264	288	
16	20	8	19	22	14	16	21	12	...	353	316	275	
18	22	8	18	20	13	17	22	13	...	379	376	340	
18	22	10	19	24	16	18	24	13	...	379	385	318	
18	22	8	17	22	11	18	22	15	.	406	387	377	
18	22	10	20	26	15	20	26	14	...	289	330	311	
18	22	10	20	25	15	20	23	14	...	328	295	278	
20	24	10	21	29	18	19	23	13	...	388	349	316	
22	18	16	22	29	14	18	24	13	...	451	339	297	
18	24	10	18	23	15	20	28	15	...	338	297	312	
20	26	10	21	27	15	18	24	12	...	476	350	336	

No.	Names of varieties.	Turned into		Dates of sowing.		Date of reaping	
		1902-03.	1903-04.	1902-03.	1903-04.	1902-03	1903-04.
					SECTION II.—Jonaria Beardless Wheats		
	Sub-section A with short thick awns.				*Spikes small and short densely packed*		
	Hard red.						
17	Jonaria, Damo . . H. R.	H. R. .	H. R. .	18th October 1902.	10th October 1903.	10th March 1903.	8th March 1904 .
	Sub-section B—Awnless.						
	Hard white.						
20	Dodi of Muzaffergarh . H.W.	H. W. .	H. W. .	11th October 1902.	10th October 1903.	20th March 1903.	12th March 1904 .
21	Daudan of Multan . „	Do. .	Do. .	Do. .	Do. .	Do. .	Do .
24	Makini of Multan . „	Do. .	Failed .	Do. .	Do. .	Do. .	Failed . .
					SECTION III.—Kala Kusal or Bakshi		
	Sub-section A.—Grains, hard, white or yellow.				*Spikelets velvetty*		
11	Palestine acclimatized Lahore H. W.	H. W. .	H. W. .	11th October 1902.	10th October 1903.	10th March 1903.	15th March 1904
19	Wadnak Amritsar . „	Do. .	Do. .	Do. .	Do. .	Do. .	17th March 1904 .
1	Bakshi Nighád, Násik . „	Do. .	Do. .	23rd October 1902.	Do .	6th March 1903.	7th March 1904
2	Pivla Bakshi Báglán „ Násik.	Do. .	Do. .	Do .	Do. .	Do. .	1st March 1904 .
3	Do. Málegaon . „	Do. .	Do .	Do. .	Do. .	Do. .	7th March 1904 .
4	Pivla Gabu Niphád . „	Do. .	Do .	Do. .	Do .	5th March 1903.	1st March 1904 .
6	Sa lhe Rahuri Ahmed- „ nagar.	Do. .	Semi H. W.	Do. .	Do. .	6th March 1903.	Do. .
7	Kálá Kusal Shevgaon . „	Do. .	H. W. .	Do. .	Do. .	7th March 1903	4th March 1904 .
8	Bakshi Paraner Ahmed- „ nagar.	Do. .	Do. .	Do. .	Do. .	Do. .	1st March 1904 .
11	Káte Kopargaon . . „	Do. .	Do. .	Do. .	Do. .	8th March 1903.	Do.
14	Pan Sangli . . . „	Do. .	Do. .	Do. .	Do. .	Do. .	4th March 1904 .
1A	Kálá Kusal Poona . . „	Do. .	Do. .	7th October 1902.	Do. .	25th February 1903.	Do. .
2	Kálá Kusal Násik . „	Do. .	Do. .	Do. .	Do. .	Do .	Do. .
4	Do. Khándesh . „	Do. .	Do. .	Do. .	Do. .	Do. .	1st March 1904
5	Pán Sangli . . . „	Do. .	Do. .	Do. .	Do .	Do. .	4th March 1904
	Bakshi Sangamner. „	Do. .	Do. .	Do. .	Do .	Do. .	1st March 1904 .
	Parner wheat . . „	Do. .	Do. .	Do. .	Do. .	26th February 1903.	Do.
	Kopergaon wheat . . „	Do. .	Do. .	Do .	Do. .	Do .	Do
1	Kálá Kusal Poona . „	Do .	Do. .	Do. .	Do .	2nd March 1903.	4th March 1904
	Kálá Kusal Poona Farm, smallest number of spikelets.	Do .	...	Do. .	Do .	1st March 1903.	...
	Kálá Kusal Poona Farm, middle grains.	Do .	...	Do. .	...	Do. .	...
	Kálá Kusal Poona Farm, from outside grains.	Do. .	...	Do. .	...	3rd March 1903.	...
	Kálá Kusal Násik . . H.W	Do. .	H. W. .	Do. .	...	10th March 1903.	4th March 1904
	Sub-section B.—Grains hard, red.						
15	Kátha Násik . . H.R	H. R. .	H. R. .	7th October 1902.	10th October 1903.	28th February 1903.	1st March 1904 .
17	Kátha Khándesh . . „	Do. .	Do .	Do. .	Do. .	25th February 1903.	7th March 1904 .
16A	White bearded Athani . „	Do .	Do. .	Do. .	Do .	28th February 1903.	1st March 1904 .
„	White awned Kátha Khándesh. „	Do .	Do. .	Do. .	Do. .	2nd March 1903.	7th March 1904 .
„	Black awned Kátha Khándesh „	Do. .	Do. .	Do. .	Do. .	3rd March 1903.	Do.
„	White bearded Athani . „	Do. .	Do. .	Do. .	Do. .	1st March 1903.	1st March 1904 .
„	Black awned Athani . „	Do. .	Do. .	Do .	Do. .	Do.	Do. .

A—*continued.*

Spikelets, 1903.			Spikelets 1904.			Spikelets, 1905.			Grains per tola				Remarks
Average.	Highest	Lowest.	Average.	Highest.	Lowest	Average.	Highest.	Lowest.	1901-02.	1902-03.	1903-04.	1904-05.	
(*Triticum hybernum*).													
with smooth round spikelets.													
18	24	12	21	28	16	18	22	13	...	410	380	495	
16	18	6	22	26	15	18	23	13	..	939	423	41.	
14	20	8	23	28	16	16	24	16	...	444	471	521	
14	22	8	...	...	...	...	..	...	...	435	...	Failed	
(*Triticum Pilosum*).													
long awned.													
22	28	14	22	19	15	...	...	...	...	686	302	...	
18	24	8	24	28	20	...	...	...	...	420	286	...	
20	24	14	20	24	14		...	...	...	505	215	...	
20	24	12	20	23	15	...	...	...	...	491	491	...	
18	22	12	20	22	15	...	...	...	...	373	378	...	
14	18	10	18	20	14	...	...	...	...	415	415	...	
1.	18	10	18	22	14	...	...	...	...	427	427	...	
16	20	10	19	21	11	...	...	...	...	432	217	...	
18	22	8	20	29	14	...	...	...	...	388	388	...	
20	24	12	20	25	15	...	...	..	...	405	405	...	
18	22	10	20	23	17	...	...	...	...	356	356	..	
20	24	10	20	24	16	...	...	...	277	324	227	...	
20	26	14	21	24	15	...	...	...	269	312	246	...	
20	26	12	20	24	15	...	...	...	264	327	271	...	
20	22	10	20	23	15	..	...	...	274	353	208	...	
16	26	12	20	25		...	...	...	330	338	240	...	
20	24	12	19	24	18	...	...	...	269	351	232	...	
20	24	12	21	26	18	19	24	13	314	303	203	243	
16	22	8	20	23	14	...	...	...	...	379	224	...	
18	22	8	...	...	...	...	...	..	...	357	...	...	
18	22	8	...	...	...	...	...	...	...	331	...	...	
18	24	8	..	...	...	...	...	...	.	335	...	...	
20	24	10	20	24	15	...	...	...	...	314	207	...	
16	22	8	17	21	11	...	...	...	256	325	213	...	
16	20	8	19	24	14	...	...	...	277	394	216	...	
16	22	8	18	21	13	...	...	...	295	343	236	...	
18	24	8	19	23	14	...	...	...	...	450	2 3	...	
18	24	8	19	25	11	...	...	...	...	203	255	...	
18	24	8	18	22	11	...	...	..	...	351	222	...	
16	22	8	17	23	14	17	23	13	...	292	208	218	

APPENDIX

No.	Names of varieties.	Turned into.		Dates of sowing.		Dates of reaping.	
		1902-03.	1903-04.	1902-03.	1903-04.	1902-03.	1903 04.
						SECTION IV.—Popatia wheats	
	Sub-section A.—Hard yellow.				*Spikes as dense as in the previous sections, but*		
1	Dándkhani Damoh H. W.	H. Y.	Semi S. W.	18th October 1902.	10th October 1903.	10th March 1903.	8th March 1904
2	Chával Kátha Bhaudare „	Do.	H. Y.	Do.	Do.	Do.	2nd March 1904
18	Tighania Nimar „	Do	Do.	Do.	Do.	Do.	Do.
12	Hansia Broach „	Do.	Do.	3rd October 1902.	Do.	8th March 1903.	28th February 1904
	Sub-section B.—Hard red with a tendency to become soft.						
23	Poptia, Nadiád	Tending to be soft.	H. Y.	7th October 1902.	10th October 1903.	3rd March 1903.	28th February 1904
17	Pel, Khándesh	Do.	Do.	Do.	Do.	25th February 1903.	23rd February 1904
16	Maliya, Belgaum	Do.	Do.	Do	Do.	Do.	Do.
21	Kátha, Baroda	Do	Do.	Do.	Do.	28th February 1903.	28th February 1904
20	Dándkhani C.	H. R.	H. R.	Do.	Do.	1st February 1903.	7th March 1904
	Sub-section C.—Hard red.						
13	Sambalpur wheat H. R.	H. R.	H. R.	18th October 1902.	10th October 1903.	10th March 1903.	28th February 1904
14	Lál Pisi, Bilaspur „	Do.	Do.	Do.	Do	Do.	Do.
15	Kátha Lalia, Damoh „	Do.	Do.	Do.	Do.	Do.	4th March 1904
16	Lál Bakshi, Málegaon „	Do.	Semi H. R.	23rd October 1902.	Do.	9th March 1903.	23rd February 1904
18	Deshi Athani Belgaum „	Do.	H. R.	Do.	Do.	Do.	17th February 1904
	Sub-section D.—Hard yellow.						
12	Dándkhani B. H. Y.	H. Y.	H. Y.	7th October 1902.	10th October 1903.	2nd March 1903.	7th March 1904
8	Pivala, Násik „	Do.	Semi H. Y.	Do.	Do.	23rd February 1903.	23rd February 1904
6	Hansiab, Broach „	Do.	Do.	Do.	Do.	26th February 1903.	17th February 1904
9	Shet, Parner „	Do.	H. Y.	Do.	Do.	28th February 1903.	2nd March 1904
10	Pivla, Khándesh „	Do.	Do.	Do.	Do.	Do.	Do
11	Sadhi Ráhuri „	Do.	Do.	Do.	Do.	26th February 1903.	23rd February 1904
14	Laskari, Kopergaon „	Do.	Semi H. Y	Do.	Do.	Do.	Do.
	Sub-section E.						
16	Bangasia, Damoh H. R.	H. R.	Semi H. R.	18th October 1902.	10th October 1903	10th March 1903.	7th March 1904
						SECTION V.—Dándkhani Wheats	
	Sub-section A.—Soft white.				*Of the color and appearance of the last section, but*		
1	Numdi of Ludhiana S. W.	Soft turning hard.	Soft turning hard.	11th October 1902	10th October 1903.	10th March 1903.	7th March 1904
2	Rangrib of Pálanpur „	Do	Do.	Do.	Do.	Do	Do.
3	Safed of Rahatsak „	S. W.	S. W.	Do.	Do.	Do.	Do.
5	Pele Torewali Karnal „	Do.	Do.	Do.	Do.	Do.	5th March 1904
9	Thakerham of Pálanpur „	Soft turning hard.	Shrivelled H. W.	Do.	Do.	Do.	12th March 1904
10	Safed of Amritsar „	S. W.	S. W.	Do.	Do.	Do.	7th March 1904
11	Daman Shera of Dehra Gazikhan. „	Do.	H. W.	Do.	Do.	Do.	15th March 1904
12	Numdi of Peshawar „	Do.	Semi S. W.	Do.	Do.	Do.	12th March 1904
13	Ghoni of Lahore „	Do.	S. W.	Do.	Do.	Do.	6th March 1904
15	Pori of Montegomery „	Do.	Do.	Do.	Do.	Do.	Do.
18	Safed of Ludhiana „	Soft turning hard.	H. W.	Do.	Do.	Do.	10th March 1904
20	Safed of Batala Gurudaspur. „	S. W.	S. W.	Do.	Do.	Do.	7th March 1904
21	Dándkhani of Delhi No. 1. „	Do.	Do.	Do.	Do.	Do.	4th March 1904
22	Dándkhani of Delhi No. 2. „	Do.	Do.	Do.	Do.	Do.	7th March 1904
23	Dándkhani of Dassaya. „	Do.	Do.	Do.	Do.	Do.	15th March 1904
25	Safed of Moga Ferozpur „	Soft turning hard.	.....	Do.	Failed	Do.	.....
8	Pissi Sukeria Damoh „	S. W.	Semi H. W.	18th October 1902.	10th October 1903.	Do.	6th March 1904
9	Pissi Inkerhai Numdi „	Do.	Do.	Do	Do.	Do.	Do.
10	Bearded white Moradabad. „	H. W.	H. W.	Do.	Do.	Do.	7th March 1904
11	Sekuraho Aligarh „	S. W.	Semi H. W.	Do.	Do.	Do.	12th March 1904
12	Mozaffarnagar „	Do.	Do.	Do.	Do.	Do.	8th March 1904
37	Numdi of Ludhiana „	Do.	H. W.	23rd October 1902	Do.	Do.	7th March 1904
7	Dandkhani „	Do.	S. W.	7th October 1902.	Do.	1st March 1903.	28th February 1904

A—*continued.*

Spikelets, 1903.			Spikelets, 1904.			Spikelets, 1905.			Grains per tola.				R
Average.	Highest.	Lowest.	Average	Highest.	Lowest.	Average.	Highest.	Lowest.	1901-02.	1902-03.	1903-04.	1904-05.	
(*Triticum Æstivum*).													
smooth; awns very long spreading in the ripe heads.													
14	18	10	15	19	11	14	18	11	...	342	240	241	
14	20	10	15	19	9	15	21	11	...	405	255	261	
16	20	10	17	22	14	...	...	...	...	461	278	...	
14	16	6	17	21	12	...	...	...	...	438	277	249	
16	20	6	16	20	10	...	...	...	262	294	263	...	
16	20	8	17	21	12	...	...	...	374	312	376	...	
16	18	6	14	18	11	14	18	10	299	359	257	324	
16	18	8	16	19	14	...	...	...	282	297	280	...	
12	16	6	13	17	10	13	16	10	266	313	287	308	
14	16	8	16	21	10	...	...	...	...	453	445	...	
18	24	10	17	19	12	...	...	...	...	416	363	...	
12	16	8	15	19	12	...	...	...	...	352	248	...	
18	22	8	17	20	12	...	...	...	...	343	261	...	
14	18	8	15	17	11	14	19	10	...	347	217	264	
12	14	8	15	20	10	...	...	...	289	338	343	...	
18	22	8	17	21	7	...	...	...	265	333	248	...	
14	16	8	15	19	10	14	18	11	237	284	224	...	
16	20	8	27	12	11	...	...	...	322	531	388	...	
18	22	8	17	20	13	..	...	...	283	395	285	...	
16	20	8	16	20	11	...	...	...	280	381	304	...	
16	18	8	17	20	12	...	...	...	293	366	316	...	
14	18	8	16	18	13	...	...	...	...	306	225	...	
(*Triticum Æstivum*).													
spikelets loosley arranged and awns much shorter.													
18	22	10	19	26	14	20	24	14	...	385	280	330	
16	20	10	17	21	10	...	...	...	...	398	300	...	
16	22	10	18	24	11	...	...	...	...	361	302	...	
16	22	8	18	22	9	...	...	...	...	367	314	...	
14	18	8	19	25	14	...	...	...	...	453	765	...	
16	22	10	18	27	12	19	25	14	...	350	208	335	
18	24	12	21	27	16	...	...	...	..	398	832	...	
18	22	10	18	23	13	...	...	...	...	409	305	...	
16	22	8	19	23	13	...	...	...	...	326	340	...	
20	26	12	19	25	14	...	...	...	...	384	380	...	
18	24	10	21	27	15	...	...	...	...	382	377	...	
18	24	10	19	25	13	...	...	...	...	421	265	..	
20	24	10	17	21	12	...	...	...	...	435	271	...	
16	22	10	7	24	12	...	...	...	...	335	259	...	
18	22	10	16	22	12	...	...	...	...	393	339	...	
18	22	10	...	Failed.	...	...	...	...	...	325	Failed.	...	
18	22	10	18	22	9	...	...	...	...	440	349	...	
18	22	10	17	21	14	...	...	...	...	440	321	...	
14	20	6	18	22	13	...	...	...	...	352	307	...	
16	20	10	18	23	14	...	...	...	..	354	429	...	
18	22	10	18	21	10	..	...	...	...	346	390	...	
18	24	10	18	23	8	...	...	...	...	352	285	...	
16	22	8	17	22	11	17	23	13	258	351	265	336	

APPENDIX

No.	Names of varieties	Turned into.		Dates of sowing.		Dates of reaping.	
		1902-03.	1903-04.	1902-03.	1903-04.	1902 03.	1903-04
	Sub-section B.— Hard white						
1	Paman Multan . . H. W.	H. W. .	... ...	11th October 1902.	10th October 1903.	Failed .	.....
14	Paman Sisa . . „	Do. .	H. W. .	Do. .	Do. .	20th March 1903.	6th March 1904 .
16	Sohon of Chiniot . „	Do. .	Semi H. W.	Do. .	Do. .	Do. .	Do. .
36	Chitri of mritsar . „	Do. .	H. W. .	Do. .	Do. .	Do .	Do. .
3	Pisi Khaleria . . „	Do. .	Do. .	18th October 1902.	Do. .	10th March 1903.	18th February 1904
6	White Pisi Jalan . „	Do. .	Do. .	Do. .	Do. .	Do. .	2nd March 1904 .
	Sub-section C.—Soft and hard red.						
22	Potia Nadiad . . S. R	H. R. .	S. R. .	7th October 1902.	10th October 1903.	10th March 1903.	25th February 1904
38	Red Deshi of Aundh . „	Do. .	H. R. .	23rd October 1902.	Do. .	Do. .	2rd March 1904 .
4	Buddha Wheat . . H. W	H. W. .	Do. .	18th October 1902.	Do. .	Do. .	6th March 1904 .
						SECTION VI.—Khapli or Spelt	
						Covered grain	
						Hard	
1	Khapli Wheat . .	H. R. .	...	7th October 1902.	10th October 1903.	23th February 1903.	.....

A—*concluded*

Spikelets, 1903.			Spikelets, 1904.			Spikelets, 1905.			Grains per tola.				Remarks
Average.	Highest.	Lowest	Average.	Highest.	Lowest	Average.	Highest	Lowest	1901-02	1902-03.	1903-04	1904-05.	
...	...	...	...	...		...	...	...	...	...	...	...	
16	24	10	18	25	14	17	23	12	...	331	316	...	
20	28	10	19	24	13	...	...	...	..	398	389	290	
18	22	10	18	23	13	...	...	..	...	416	370	.	
16	20	10	16	21	10	...	...	...	...	428	369	...	
1°	22	10	17	21	12	...	..	...	...	331	322	...	
20	24	10	17	21	14	19	25	14	350	391	339	330	
18	24	10	17	24	13	17	22	12	...	438	365	...	
16	22	10	18	24	13	18	24	13	...	470	335	300	In 1902-03 mixed W and R.
(*Triticum Spelta*).													
wheat.													
Read.													
20	26	10	20	27	11	...	...	...	326	301	...	328	

APPENDIX B.

Cutch.—Wheat, *ghau, Triticum Æstivum,* is chiefly irrigated. Unwatered wheat is grown only in parts of Vagad liable to flooding. Some soils in the coast alluvial lands, *kanthi,* are suited to the growth of wheat, but they are of small area and by the beginning of the cold weather the land is generally too dry for sowing wheat. Wheat is generally reaped in February (Maha). The average produce of irrigated wheat is about fifteen-fold rising to thirty-fold in very good seasons.

Ahmedabad.—Wheat, chiefly from Dholka, Dhandhuka and Viramgám, holds the first place, within 1877-78, 230,307 acres or 26·37 per cent. of the whole village area. There are two chief varieties—*chasia* grown in Dholka, Dhandhuka, Viramgám, sánand and Gogha, and *vadina* or *vajia* grown in Daskroi and Prántij. *Chasia* is of two kinds, *katha* red and *daudkhani* white. Of these only the red is sown in Dhandhuka as the salt subsoil is believed to be unfavourable to the white. *Chasia* is grown in light black soil without watering. Eighty-four pounds of seeds are used to the acre. Except when it takes the place of a failed cotton crop, the same field in one year yields nothing but wheat. Land intended for wheat is left fallow and ploughed four times before the seed is sown. The first ploughing is in May or June before the rain sets in. The crop is sown at the end of October or beginning of, November and reaped in April. The average acreage yield of *chasia* is estimated at 258 pounds. *Vadina* or *vajia* is sown in watered light sandy soil at the rate of 160 pounds of seed to the acre. It sometimes follows rice or millet, but in such cases the outturn is small. Except that three ploughings are enough, it is grown in the same way as *chasia.* It is sown in December and reaped in April. The average acre yield is estimated at 600 pounds. *Chasia* suffers from frost, grasshoppers, *kapdi* and other enemies. *Vadina* or *vajia* is liable to mildew, known as *geru, gewar* or *jeru.* This disease attacks watered wheat only. It gives the young plants a reddish tinge, the color growing more and more marked as the disease spreads. There is no known remedy for it. White or *daudkhani* wheat commands so high a price for house consumption that it does not pay shippers to export it. The Dholka *Vajia* wheat is said to be suited to the export market and to be similar to the lower class-red *pissi* of the Central Provinces.

Kaira.—Wheat is sown from the beginning of October to the end of November and reaped in March. Three sorts are grown, *daudkhan* or *dudhia,* a high class wheat, smooth grained and white; *dhola* or *katha,* a low class wheat, hard and brown; and a medium variety *dhalia* or *vajia.* The high class *dudhia* wheat grows only in black soil. For a good harvest the field should be fallow both before and after its wheat crop. It should be ploughed from three to ten times and unless the soil is of the best, it should be manured. This sort of wheat requires forty pounds of seed to sow an acre. The middling *vajia* and the poor *dhola,* grow either in black or in sandy black soil. For a good yield, except in the best black soils, manure is wanted, but neither before nor after cropping is a fallow required. To sow an acre they both want sixty pounds of seed. The local wheat produce is not enough for the local demand. Supplies are brought from Ahmedabad and Málwa and by rail from Bombay.

Panch Mahâls.—Wheat, *ghau, Triticum Æstivum,* within 1876-77, 8,553 acres is in the eastern division, a leading and increasing product. Five varieties are grown, *daudkhani,* white-brown, very clear and full; *kátha málvi,* not so full as *daudkhani,* with a mixture of inferior reddish wheat; *kátha dándi,* thin, hard and not full, a mixture of white-brown and reddish grain; *gomadia,* a low class *daudkhani,* of dull white-brown with thin and shrivelled grain. Wheat is grown in stiff black loam and to a less extent in medium black, *besar,* soil. It is usually sown as a second crop following rice or maize. The sowing is in November and December. Before sowing the land is ploughed and when levelled by the clod crusher, the seed is sown at the rate of from forty to sixty pounds the acre in drills about one foot apart. Manure is seldom used.

Rewa Kántha.—The wheat grown in this district is of two kinds, *vájia* and *katha.*

Cambay.—The wheat is said to be the same as that grown in the neighbouring parts of Kaira.

Kathiáwár.—Wheat is an important crop in all parts of Káthiáwár which have good water and suitable soil. It grows in black soil and is usually watered expect in the east of the province where the low lands of Bhál, Nal Kántha, Jhinjhuváda, Dassadsal, Balagam, Mahiari and Ganod, enriched by yearly floods, yield crops of wheat without water or manure. The unwatered wheat gives a less yield than the watered wheat, but commands a slightly higher price. In other parts of the province, to grow wheat the soil has to be ploughed six times and watered ten times and each acre requires fifteen to twenty cart-loads of manure. Wheat is sown in the end of October and reaped early in March. Growing wheat, either from frost or from heavy rain, is liable to a blight called *gheru*, which stops the growth of the seed and in some cases destroys it. There are two leading kinds of wheat, *kátha* or *chásia*, a large sweet hard grain not much subject to the attacks of vermin and fetching a good price; and *vághia* a smaller variety of less value and darker colour. Wheat is used by all classes, but as it is dearer than millet, it is the staple food only of the rich. Part of the crop is generally exported from Bhávnagar and Limbdi. The reports vary greatly from year to year. In a good season Bhávnagar has exported as much as 2,500 tons.

Broach.—Wheat, *ghau*, holds the third place among the crops of the district. Crops of wheat suffer in the same way as fields of *juvár*, the open plains on which it grows abounding with herds of antelopes and flocks of cranes. Two kinds of wheat are raised in this district; the *hansia*, a white grain, and the *kátha*, which has a reddish tinge, and is less valuable by about twenty per cent. The wheat most commonly grown is bearded. It reaches a height of 18 inches. Sown late in September or early in October, it ripens in March, when it is pulled up by the roots, carted to the village threshing floor and trodden out by cattle driven round a post. Wheat is, perhaps, the most uncertain of all crops. If there has been too little rain, it is eaten up by a small locust, *khaphedi*. If the rains have been too excessive, the crop is blighted. Another objection to the culture of wheat is the large quantity of seed required. This is not less than forty pounds an acre and has generally to be borrowed from the village grain-dealer at about twice its value. In 1892, several experiments were made to test the average yield of wheat. In six of these, made in good and average soils, it was found that, without irrigation or manure, an acre will yield from 420 to 1,476 lbs.

Ahmednagar.—The uncertain rainfall is a great obstacle to the growth of wheat in Ahmednagar. Five varieties, two of them watered or garden, *bakshi* and *khaple* or *jod* and three dry-crop or field varieties, *pivle*, *kathe* and *pothe* are grown. *Bakshi*, which is also called *banshi*, wheat is yellow and large and in ripening turns purple bearded. It is the most esteemed variety, but it is not hardy enough to be much grown. It is occasionally grown in dry-crop land. *Khaple*, also called *jod*, is very hardy, but requires pounding to separate the husk. The differences in the dry-crop varieties are, in Mr. Ozanne's opinion, the result of climate and soil. In some soils and climates the field wheat or *shet gahu* keeps the characteristics of a hard, light yellow, semi-transparent grain, in shape long and arched. It is then styled *pivla*. It is also called *dándkháni* and ranks next to *bakshi* which it resembles. In most parts of Ahmednagar, even where the purest *pivla* is sown, in a year or two a mixture of hard red or dull brown grains appears. When the inferior grains do not exceed fifty per cent. the appropriate name is *kate gahu*. In some seasons, notably when a heavy monsoon is followed by October rain and also by a little rain after the wheat is sown, a number of the yellow and red grains develop a non-transparent, white ricey look. When these appear the wheat is said to have become *potha*. The market price is highest for *bakshi* and *pivla*, and considerably lower for *kate gahu* or dull brown. The more *potha* or white marked grains in the dull brown, the smaller the value of the wheat. In many parts of Ahmednagar, *pivla* wheat in two or three years will always become mixed with *kate gahu* or dull brown and frequently with *pothe gahu* or white spotted. On the other hand there is little doubt that even in the best seasons *pothe gahu* or white spotted will not produce good *pivla*. The general opinion is that the quality of the wheat is better in the lighter soils, but the outturn is generally so

much larger that black soil is perferred. Wheat keeps good for several years in *pevs* or grain pits, in the open air it soon turns bad. By itself wheat straw is held to be unwholesome for cattle.

Mr. Ozanne is of opinion that not much improvement in wheat cultivation will result from the use of imported seed. The wheats of each district show what variety is best suited to them. After the famine, Jabalpur *pissi* wheat, a soft white, was sown in the Athni Sub-division of Belgaum. It rapidly degenerated to a hard red. . Kanhur-pathar dry-crop *baksi*, a celebrated variety from an elevated portion of the Parner Sub-division of Ahmednagar was sown by two good farmers in Nevasa in dry-crop land. In two years it became so like the ordinary *shet gahu* that it could not be distinguished from it. In certain Parner villages, especially Brahmangaon, the *pivla* wheat keeps its colour and other characteristics. This, sown in Nevasa, in two years degenerated into *Kate gahu*. Mr. Ozanne thinks that in dry-crop land every encouragement should be given to the sowing of good *pivla*. If it falls off fresh seed should be brought from villages where it grows well The people are alive to their own benefit and would adopt such suggestions. But their interest in improving wheat is of recent date. Till wheat came into foreign demand, it was grown less extensively and stored in pits to be used in years of scarcity. Naturally, little care was taken to improve it.

Nasik.—Wheat is grown in all sub-divisions and is either a dry or a watered cold weather crop. Wheat is of five kinds, *banshi* or *bakshi*, *daudkhani*, *kathe*, *bodke* and *khaple* also called *khavde* or *jade*. Of these *banshi* is a watered crop, *daudkhani*, *kathe* and *bodke* are dry-crops and *khaple* is both dry and watered. *Banshi*, also called *bahmini*, a yellowish wheat, the favourite kind in garden land, is soft, large or middle sized, and black bearded. Next to it comes *daudkhani* wheat which is yellow. *Kathe*, *bodke*, or the beardless, and *khaple* are hard, reddish and small grained. *Khaple* is as good as *daudkhani*, but wants much clarified butter when it is used as food. *Kote*, a local variety of overwatered *daudkhani*, is soft, yellow and small grained and is generally chosen as a second crop. It grows only on sandy and poor soils.

Wheat is sown from September to November and reaped from January to April. From 24 to 80 pounds of seed are required to sow an acre. When ripe the plants, except in watered lands where their hold is firmer, are pulled out by the roots, bound into large sheaves, carried on carts to the threshing floor and trodden under bullocks' feet. The average acre outturn is about 360 pounds in dry and 780 pounds in garden lands. The produce is more than enough for the local demand.

In Palanpur State wheat is mentioned as one of the staple crops.

Mahi Kantha.—Wheat is sown in dry lands in October and November and reaped in March and April.

Poona.—Wheat is a late or cold weather crop (October—March). It requires a moister climate than *jawari* and in the eastern fringe of the west lands is generally grown as a dry-crop. Elsewhere it is grown as a dry-crop only in favoured places, but over the whole eastern plain it is largely grown as a watered crop. Wheat wants black or rich soil. The best soil is the alluvial loam known as *gavhâli* or the wheat land. Wheat also thrives in the low lying black or better brown clay soils in low lands where drainage gathers. Four kinds of wheat are grown, *bakshi*, *kate*, *khaple* also called *jod* and *pote* that is, big-bellied. *Bakshi* requires good black soil. It is sown in October or November, is usually watered and manured and is reaped in February or March. This wheat is of the finest quality but as it is delicate it is not largely grown. The stem is sometimes as much as five feet high, the grain is larger than the grain of other kinds of wheat, and the beard, when ripe, is tipped with black.

Kate wheat is sown in good black soil in October, is usually watered but not manured, and is reaped in February. It is shorter stalked and smaller grained than either the *bakshi* or *khaple*, is hardier than the *bakshi* and is the wheat commonly grown in dry lands.

Khaple or *jod* husk wheat, is sown in black soil in November, is always both watered and manured, and is reaped in March. *Khaple* is the wheat usually grown in gardens. It is very hardy. It owes its name to the fact that the grain cannot be separated from the husk without pounding. It is

grown as a second or *dusota* crop in January and February in irrigated lands after *bajri*, maize, tobacco, chillies or wheat with good result.

Pote or big-bellied wheat is less esteemed than other varieties. It is grown in poor black soils in November, is neither watered nor manured, and is reaped in February.

Other varieties known in the district are *daudkhani* and *kále kusal*. The average yield from all kinds of wheat in unwatered land is 500 or 600 pounds and in watered land 1,000 to 1,100 pounds. In garden land wheat follows rice and in dry-crop land it comes best after *bájri*, maize, tobacco or chillies.

Wheat straw is eaten as fodder with or without a mixture of chaff.

Sátára.—Wheat is grown all over the district as a cold weather crop being sown in October and November and reaped in February and March. It requires a moister climate than *jowári*. It is generally grown as a dry-crop, but much watered wheat is also raised in all parts of the district. Two kinds of wheat are grown, *bakshi* and *khaple*. *Bakshi*, which is usually watered and manured, is sown in rich black soil in October or November and reaped in February or March. It is the finest variety of wheat, but from its want of hardiness is not much grown. The stem is longer, sometimes five feet high, and the grain is larger than in other varieties, and the beard, when ripe, is tipped with black. The straw, when broken and mixed with chaff, is used as fodder.

Khaple also called *Jod* or husked wheat, always watered and manured, is sown in good black soil in November and is reaped in March. Its hardiness makes this the favorite garden wheat. It is called *khaple*, because the grain cannot be separated from the husk without pounding. From 2½ to 3½ pounds of wheat are sown to the acre, the better the soil the less the seed.

Belgaum.—Three varieties of wheat are grown in Belgaum, *tambda* or red, *khapli* and *holi*. The *tambda* or red is the best variety and is like English wheat. The *khapli* is a bearded wheat like English barley, except that the grain is oblong. It is grown as a watered crop in garden lands. The *holi* is an inferior wheat grown in rice lands after the rice has been carried. Wheat prospers only in good black soil. The quantity of seed varies from twelve to thirty-two pounds an acre. In wheat growing lands, the best succession of crops is said to be Indian millet the first year, cotton the second year, wheat the third year, Indian millet the fourth, cotton the fifth, and wheat the sixth, and so on in the same rotation. In some places wheat alternates with sugarcane and gram. Occasionally *kusbi* or safflower is raised two to six feet apart between the rows of wheat. The safflower does not ripen till one month after the wheat, that is about the end of March, and in no way interferes with its growth.

Sholapur.—Wheat is generally grown in the best black soil. Ithas two chief varieties, *sheta* a dry-crop and *khapla* or *jod* a watered garden crop. About 16 pounds of seed are required to sow an acre of wheat. Wheat is sown in October and reaped in February.

Dharwar.—The three chief varieties of wheat are the *tambda* or red, the local or *jowari* apparently meaning Karnatak and the *deshi* also local apparently meaning Deccan. Of these the red is the finest and is much like English wheat. Wheat is the last sown of the cold weather crops. It is not sown till the October rains are over, and there is no chance of more rain.

Wheat is grown every third year and is followed by Indian millet. In some places wheat alternates with sugarcane and gram and occasionally safflower is raised between the rows of wheat two to six feet apart.

Bijapur.—Three chief varieties of wheat known as *tambda* or red, *khapli* and *holi*, are grown. The *tambda* or red wheat is the best and is like the ordinary English wheat. The *khapli*, grown as a watered crop in garden lands, is a bearded wheat like English barley except that the grain is oblong. The *holi*, an inferior wheat, is grown in rice lands after the rice crop has been carried. As a dry-crop wheat is grown in pure black soil, in mixed soil called *mali* and in grey soil formed from felspar rocks. Of these, the mixed or *mali* lands are the best suited for the growth of wheat. The wheat of the Don Valley has a high local value: the salt in the soil instead of injuring nourishes the wheat plant. The crop which wheat follows best is cotton preceded by Indian millet. In some places wheat alternates with

sugarcane and gram. Occasionally *kardai* or safflower is raised between the rows of wheat two to six feet apart.

Presidency Proper.

Wheat.—

In 1902-1903—1,241,000 acres, 8 per cent. of the total area under crops.
In 1903-1904—1,555,000 acres, 9 per cent. of the total area under crops.

I.—Gujarat, 1903-1904—

Ahmedabad	14	per cent.
Kaira	2	„
Panch Maháls	3	„
Broach	14	„
Surat	7	„

II.—Deccan—

Khándesh	4	„
Násik	13	„
Ahmednagar	7	„
Poona	5	„
Sholapur	3	„
Sátára	3	„

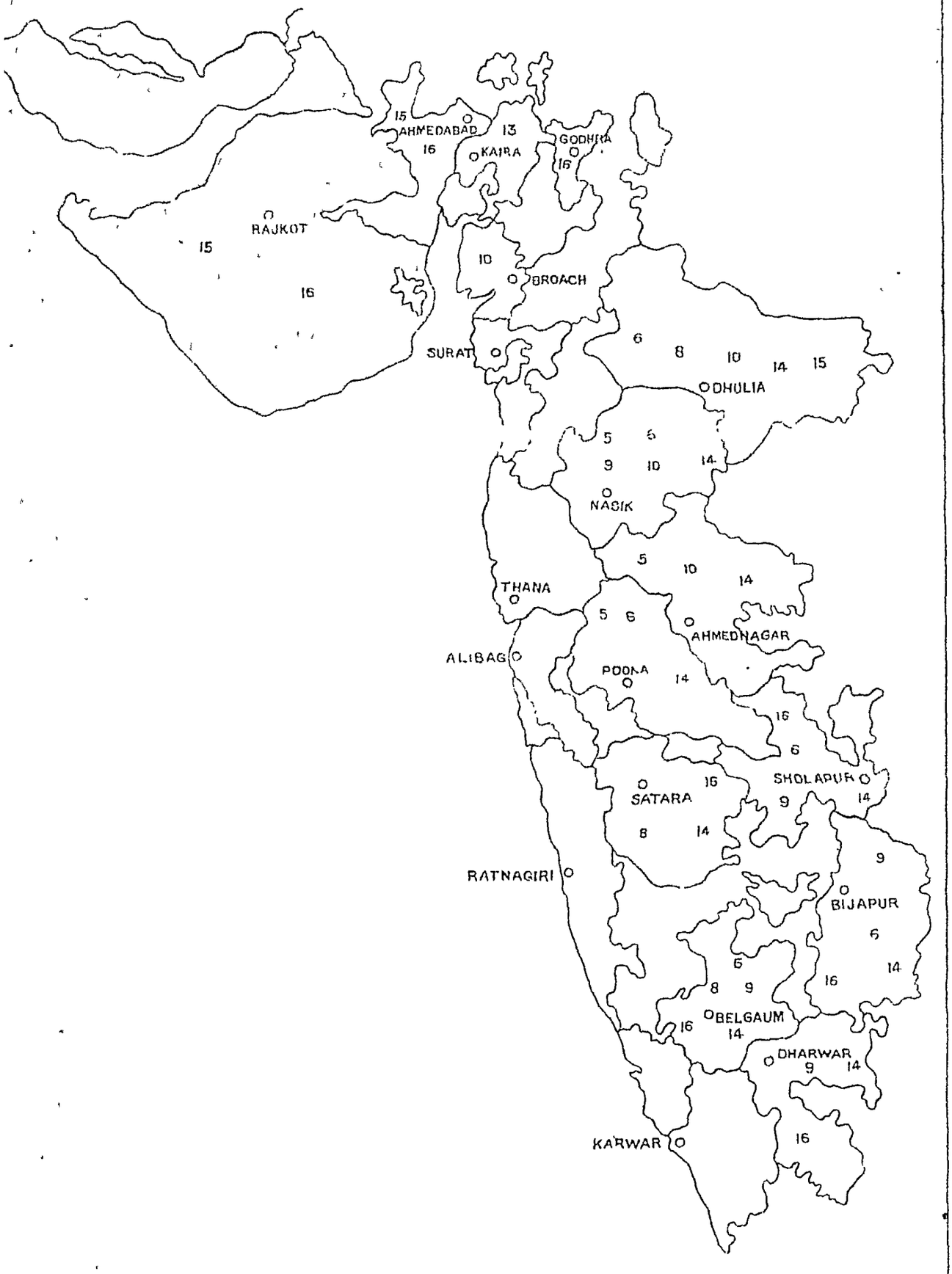
III.—Karnátak—

Belgaum	6	„
Bijápur	6	„
Dhárwár	13	„

IV.—Konkan—

None.

APPENDIX C


AHMEDABAD
KAIRA
GODHRA
RAJKOT
BROACH
SURAT
DHULIA
NASIK
THANA
AHMEDNAGAR
ALIBAG
POONA
SHOLAPUR
SATARA
RATNAGIRI
BIJAPUR
BELGAUM
DHARWAR
KARWAR

SIND.

The Mirpurkhás, Dhárwár and Dhulia Farms are alone in wheat growing tracts. Varietal trials are being conducted on all of them and on the first named a series of hybrids is being grown.

2. My investigation of Sind wheats is not complete and as the question is a very large one, I cannot hope to answer all the points detailed in the accompaniment to the Inspector General's No. C.-1053—8-4 of 4th October 1905: such information as I have is given below.

3. *Varieties, etc.*—The types in greatest demand for export are the soft red and white varieties; a small quantity of hard wheat is grown for local consumption. All are grown on alluvial soil and irrigated from canals (either perennial or inundation). On the Jámrao Canal both red and white varieties are grown but not pure.

4. *Source of seed.*—As far as my knowledge goes the ryot saves his own seed.

5. On inundation canals the rotation is generally jowár (or bájri) one year and wheat another, but in some cases, wheat alone is grown. On the Jámrao the rotation is cotton one year and wheat the next with catch crops of jowár and bájri. In all cases long fallows are given periodically.

6. *Threshing and winnowing.*—Some of the dirt is due to the method of threshing but some is also added by dealers.

7. *Refraction.*—This is, I believe, 4 per cent.

8. *Percentage of wheat exported to that grown.*—I have no figures on this point but almost all the wheat is exported.

9. *Damage by weevils* is small if proper precautions are taken, *viz.*:—

(*a*) in keeping grain for seed to put the grain in bins of sun-dried earth, and

(*b*) keeping grain for export in dry well-aired stores.

10. *The port of shipment* is Karáchi.

11. *Experiments on wheat improvement.*—

(*a*) On the Mirpurkhás Farm 15 acres are under wheat (both Indian and foreign).

(*b*) Varieties (both Indian and foreign) and hybrids are grown.

(*c*) The method adopted is to select both in the field and in the store.

(*d*) Results of previous spasmodic experiments have been apparently *nil*.

(*e*) Tests before distribution have not hitherto been applied.

(*f*) Wheat distribution is effected through the local revenue officers.

(*g*) In previous experiments practically no control has been exercised, except so far as revenue officers could effect this. For the improvement of this important item I have made proposals in my letter No. 2082, dated 14th November 1905, to your address. With the present staff and the method of organization nothing can be seriously attempted either in the improvement of wheat in Sind or the other and more important questions demanding solution in Sind.

12. As far as I know no foreign wheats have been adopted by cultivators.

13. Neither are Indian varieties introduced within the last ten years grown to any extent at all.

14. As no conclusive experiments have as yet been made, no results have been published. I may add that this Department began experimenting in Sind less than two years ago.

F. FLETCHER, M.A., B.SC.,
Deputy Director of Agriculture, Bombay.

UNITED PROVINCES.

1. *Varieties.*—The classification of the wheats in the United Provinces has been in progress only for one year and is not yet complete. The distribution

of the various kinds so far identified can best be seen from the preliminary classification appended to this note, which also gives the native names attached to the varieties.

So far as concerns the Himalayan alluvium (including the great majority of the wheat area), questions of soil and irrigation do not arise in connection with the different types of wheat. All are sown on loam (the stronger loams for preference), and irrigated where the climate and weather necessitate this course.

In the Central Indian alluvium (the Bundelkhand districts) the wheats grown vary to some extent with the soil, but the facts have not yet been recorded with precision.

The various wheats shown in this classification have been under observation for so short a time that it is not possible to give definite information, regarding the relative liability to rust. The incidence of rust in these Provinces appears to vary with the climate; it occurs everywhere in years favourable to its development; but in the north and west it is not known ever to have amounted to a serious calamity; in the centre and east it may be serious, or very serious, involving reduction of the outturn by from one-quarter to possibly one-half in the worst localities. In the Bundelkhand districts it is most serious of all and has been known to lead to a total loss of the crop over not inconsiderable areas.

The area occupied by the four main types is not recorded separately, and conjecture regarding the proportion of each would be futile, but the soft white wheats are believed to occupy the bulk of the area.

Exports consist mainly of the soft white wheats. These wheats are also in demand for local consumption in the western parts of the Provinces, but in the east there appears to be a preference for red wheats.

2. *Uniformity of sample.*—The appended classification will show that most of the samples received from districts were pure, but that a considerable number were mixed. Speaking generally, cultivators who save their own seed do not intentionally mix varieties, but keep the seed pure or with at most a small proportion of other varieties that have come in accidentally. The poorer cultivators, who depend on grain-dealers for seed, have usually to grow mixed seed, as the grain-dealer does not keep the varieties separate. In Bundelkhand it is usual to mix varieties as a form of insurance against accidents of season, but the exact nature of the mixtures preferred in this case has not yet been ascertained with precision.

3. *Sources of seed.*—The source of seed for sowing is purely an economic question in these Provinces. All cultivators who can afford it keep their own stock of seed, and this is the usual practice in the north and west; but in the south and east, where poverty is greater, the seed is usually obtained from a local merchant.

4. *Rotations.*—Wheat is a rabi crop. (*a*) It is rarely grown after a kharif corp in the same year; in fact this is done to any extent only in Rohilkhand, where it follows early maize. (*b*) More commonly it is grown after a rabi crop in the preceding year (*i.e*, with six months' fallow): the preceding rabi crop in this case is usually either gram alone or a mixture of crops containing gram or peas. (*c*) A common practice is to grow wheat after sugarcane (eight to nine months' fallow), in order to make the most profitable use of the manure left over by the sugarcane, which has usually been treated liberally. (*d*) Very occasionally wheat follows rice grown in the preceding year; so far as I know this is done only where the land is in exceptionally good condition. (*e*) Wheat used to follow indigo grown in the hot weather, but the disappearance of indigo has made this process rare. (*f*) The commonest rotation of all is for wheat to follow a kharif crop of the preceding year, *juar*, *bajra* or cotton, mixed in most cases with *arhar* or a creeping pulse (*e.g.*, *urd*, *Phaseolus radiatus*), or with both of these. If there is no *arhar*, the land gets about ten months' fallow; if there is *arhar*, the millet or cotton is off the ground in December, the *arhar* stays till April, and there is six months' fallow after its removal.

After wheat it is almost universal to take a mixed kharif crop containing *arhar* or a creeping pulse or both. The exceptions are (*i*) if the field is low-lying or for any reason cannot be cultivated in the kharif, it is sown with a

rabi mixture containing gram or peas with barley ; (ii) if the wheat has been exceedingly good and the land is clean, a cultivator sometimes takes a second crop of wheat off it. Outside Bundelkhand I have never heard of a thir being taken without a pulse-mixture intervening.

The foregoing refers to irrigated wheat, as the practice of irrigation is almost universal. Dry wheat in the *bhat* (calcareous) soil of the north-east is grown on the same rotations as irrigated wheat elsewhere. In Bundelkhand, where wheat is grown dry on the heavier soils, it is rare to find it grown without an admixture of gram ; the mixture wheat-gram usually follows *juar* in the kharif of the previous year, or else wheat-gram in the previous rabi. There are a few tracts in the black soils of Bundelkhand where wheat has been grown regularly for many years without any rotation and with continued excellent results, but they have not yet been fully studied.

5. *Adulteration.*—There is no evidence to prove that the cultivator adulterates wheat. All experience goes to confirm the conclusions drawn in paragraphs 383--387 of Voelcker's report on the improvement of Indian Agriculture. Adulteration is practised by the local grain-dealers, because exporters buy on the assumption that impurities reach a certain percentage. A small proportion of other seeds and of dirt is taken up from the threshing floor, but ordinarily these amount to 1 to 2 per cent. of the whole.

6. *Refraction.*—The percentage of refraction of exported wheats appears to vary from 5 to 10 in an ordinary year, according to information furnished by a few firms and to examination of samples ready for export. Six or seven per cent. is probably about the usual standard.

7. *Percentage of export.*—The following table shows the production of wheat in the Provinces as estimated in the final report on this crop with the net exports (both to other parts of India and abroad) from the Provinces during the year (from April to March) following the harvesting of the crop :—

Year.	Produce.	Net export.		Percentage exported.	Retained for consumption. Maunds.
	Amount. Maunds.	Year.	Amount Maunds.		
1900 . . .	65,791,000	1900-1901	10,196,000	15·	55,598,000
1901 . . .	65,100,000	1901-1902	2,327,000	4·	62,773,000
1902 . . .	65,573,000	1902-1903	8,749,000	13·	56,824,000
1903 . . .	81,149,000	1903-1904	14,389,000	18·	66,760,000
1904 . . .	88,179,000	1904-1905	21,978,000	25·	66,201,000

These figures show that the Provinces need for home consumption from fifty-five to sixty-five million maunds according to the condition of the people ; the increased local consumption in the last two years is natural in view of the increased prosperity of the people during that period. The balance available for export depends (1) on the weather before seed time, which determines the area it is possible to sow; (2) the condition of food stocks, which determines the proportion of area that is put under wheat; (3) the weather during the growing period, which determines the outturn per acre. Food stocks were still depleted in 1900, and coarser grains were grown for home use; by 1903 stocks were high and larger areas were put under wheat almost throughout the Provinces.

Thus the provinces grow wheat mainly for the local market, and the export trade is largely accidental; the only exception is the country about Meerut which expects a regular export beyond India.

8. *Loss by weevils.*—Injury from weevils sets in with the rains, while the bulk of the crop available for export has usually been moved before this period. Most of the balance is stored during the rains, and exported in the cold season if it has escaped weevils in storage. So far as is known the loss on exported

wheats is not great, being limited to the comparatively small quantities that are moved during the rains, and no special methods of avoiding it are practised, the storage being the same whether the wheat is to be exported or retained. There is undoubtedly a loss on the wheat stored in the country which is important in the aggregate, but is very small compared with the quantity that is safely stored.

The methods of storing are :—

(1) Grain pits known as *gar* or *khutti* dug in the ground in the shape of a truncated cone with the base downwards. The interior is plastered with mud (very occasionally tarred), and leaves are burnt in the pit before storage. The floor is then spread with dried leaves (mango and *mahua*), the grain heaped on it and covered with chaff (*bhusa*) and dried leaves.

(2) A corner of a room in the cultivator's house is separated off by wicker bundles and the grain is stored in it packed in chaff (*bhusa*). The room is kept closed and as dry as possible.

(3) The grain is stored in earthen bins packed with chaff (*bhusa*).

The pits appear to be more effective than the other methods described.

9. *Ports of shipment.*—The figures given in paragraph 7 show the net exports to all parts of India, including the ports; they are *net* because some parts of the Provinces import wheat while others export, and hence cannot be compared precisely with the figures given below for gross exports. The gross exports to the ports are distributed as follows :—

Year.	Total maunds.	Percentage of production.	Calcutta.		Bombay.		Karachi.	
			Maunds.	Percentage of export.	Maunds.	Percentage of export.	Maunds.	Percentage of export
1900-1901 .	1,469,000	2·	1,235,000	84·	233,000	16·	...	...
1901-1902 .	2,082,000	3·	1,959,000	94·	117,000	6·	5,000	...
1902-1903 .	5,193,000	8·	3,879,000	75·	706,000	14·	607,000	11·
1903-1904 .	12,596,000	15·	9,094,000	72·	1 ,14,000	10	2,187,000	18·
1904-1905 .	21,001,000	24·	12,916,000	62·	4,221,000	20·	3,864,000	18·

It must be clearly understood that the exports of the last two years were drawn from good crops on exceptionally large areas. In ordinary years not more than 10 per cent. of the crop of these Provinces is likely to leave India and in unfavourable years the export disappears entirely.

10. *Experiments.*—Wheat is largly grown at the Cawnpore Farm, where it is the typical crop for the study of soils, manure, etc., but the experiments directed to improving the wheat itself occupy only a small area, part of which is at Cawnpore and the rest is at Orai in Bundelkhand.

The object of these experiments is to find a wheat suitable to the special conditions prevailing in Bundelkhand: existing wheats that seem suitable are tried at Orai; hybrids are produced at Cawnpore (for convenience of supervision), and those that seem promising are sent to Orai for trial. The trials are carried out first in single drills, where the features of the variety can be studied in detail; if a drill looks promising, the seed of it is saved and sown in a small plot in the following year; and the wheats that do best in small plots are then repeated on larger areas. The tests have to be continued till the crops have been through (*a*) a dry, (*b*) a rusty season; hence progress is slow.

11-12. New varieties of wheat have not been introduced to the public from Australia or other countries or from other Provinces of India.

13. Results are published from time to time in the Farm Reports in English, and in the *Agricultural Journal* in vernacular; but so far results in the line of research indicated above are not sufficiently ascertained for publication.

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Director of Agriculture, United Provinces.

PRELIMINARY CLASSIFICATION OF THE WHEATS OF THE UNITED PROVINCES.

SECTION I.—*Bearded.*

Wheats.	Remarks.
(*a*) SPIKES MEDIUM, LIGHT STRAW COLOUR OR PALE YELLOW, GLABROUS, AWNS $2\frac{1}{2}$" TO 3" LONG, SPREADING WHEN DRY.	
(I) Soft White.	
Bran, light straw colour	
Dehra Dun, Mihirta	
Muzaffarnagar, Safeda	
Meerut, soft white	
From Bulandshahr, Safed	
Ditto, ditto	
Bulandshahr, Munia	
Ditto, white	
Ditto, Gajar	
Muttra, Safeda	
Etah	Mixed with hard.
Muradabad, Gajra	
Ditto, Khadir Awal	
From Moradabad, Cawnpuri	
Ditto, Safed doom	
Budaun, Ratna	Mixed with hard.
Ditto, white	Ditto.
Kheri, soft white	Ditto.
Bahraich, ditto	Ditto.
Ditto, ditto No. 2	Ditto.
Gonda, Dandi	Ditto.
From Sitapur	Ditto.
Ditto, soft white	
Unao, Safed	
From Unao, Sambhargchna	
Partabgarh, white	
Benares, Dandi	
Banda, Gangajali	
From Banda, Pissi Gangajali	
Ditto, Ujaria	
Banda, Ujaria	
(II) Hard White.	
Bran, light straw colour	
From Bareilly, Kathia	Mixed with soft.
Aligarh, Kathia	Ditto.
Etah, Sambharia	Ditto.
Mainpuri, Sambharia	Ditto.
Ditto, Anokha	Ditto.
Cawnpore, Tamra	Mixed with soft. Sample not correct.
(III) Hard Red.	
Bran light straw colour	
Moradabad, red Khadir	Mixed with soft
Ditto Surkh	Ditto.
Bahraich, red soft	Ditto.
From Sitapur	Ditto.
Banda, Kathia	Bad, mixed with soft. Sample nearly all soft.
Do., red hard	Mixed with soft.
(IV) Soft Red.	
Bran, reddish brown	
From Muzaffarnagar, Safed doom	
Bulandshahr	Mixed with hard.
Fatehpur, Pissia Awal	Ditto.
Banda, do. wheat	Ditto.
Do. red wheat	Ditto.
Lalitpur, Pissi doom	Ditto.

SECTION I.—*Bearded.*—(contd.)

Wheats.	REMARKS.
(*b*) SPIKES MEDIUM, WHITISH, DOWNY AWNS, 2″ TO 3¼″ LONG, SOMEWHAT SPREADING WHEN DRY.	
Soft White.	
Bran, pale, whitish	
From Unao, Sambhargehna	
(*c*) SPIKES REDDISH BROWN, GLABROUS, AWNS 2½″ TO 3″ LONG, SPREADING WHEN DRY.	
Hard White.	
Bran, light straw colour	
From Bareilly, Pissia	
Bareilly, soft white	
From Bareilly, Kathia	
Shahjahanpur, Sambhari	
Lucknow, Hamla	
Unao	
Partapgarh, Lalia	
Gonda, Dandi	
Basti, Gangajali	
Azamgarh, Dandi	
Cawnpore	
From Banda, Pissia white	
Ditto, Ujaria	
Banda, Ujaria	
From Banda, Pissia Gangajali	

SECTION II.—*Bald (occasionally short awned).*

Wheats.	REMARKS.
(*a*) SPIKES LIGHT STRAW, COLOUR GLABROUS.	
Hard White.	
Bran, light straw colour, Bulandshahr, Mendha Moradabad, Mundia Soft Awal	
From Moradabad, Mundia Soft doem	
Moradabad, Khirtta Awal	
Ditto, Safed Mundia	
From Moradabad, Kathiar doem	
Ditto, Cawnpore	
Budaun, Ratna white	
Ditto, Bahamaria white	
Partabgarh, Mundwa	
(*b*) SPIKES LIGHT STRAW, COLOUR DOWNY.	
Soft White.	
Bran, light straw colour	
From Saharanpur, Munda	

SECTION II.—*Bald (occasionally short awned).*—(contd.)

Wheats.	Remarks.
(*c*) SPIKES REDDISH BROWN, GLABROUS.	
Hard White.	
Bran, light straw colour	
From Saharanpur, Munda	
Do. Moradabad, Katehar doem	
Do. Bareilly, Kathia	
Do. do. Pissia	
Do. Sitapur, Mundia	
Do. do. Muria	
Bara Banki, Marwa	
Unao, soft white	Samples not correct.
Partabgarh, Dandi	Ditto.
Fatehpur, soft white	Ditto.
Ditto, Muria	
From Banda, Ujaria	
Banda, Pissi Gangajali	
Soft White.	
Bran, light straw colour	
Cawnpore	
From Banda, Ujaria	
Ditto, Pissia white	
Soft Red.	
Bran, light reddish brown	
From Saharanpur, Munda	
(*d*) SPIKES REDDISH BROWN DOWNY.	
Hard White.	
Bran, light straw colour	
Saharanpur, Muria	
From Saharanpur, Munda	

SECTION III.—*Bearded (awns short).*

Wheats.	Remarks.
SPIKES SHORT, YELLOWISH, GLABROUS, GLUMES ROUNDISH, AWNS SHORT, 1″ LONG, GRAIN SHORT PLUMP ROUNDISH.	
Hard White.	
Bran, bright transparent	
Partabgarh, Mundia	

SECTION IV.—*Bearded (awns long).*

Wheats.	Remarks.
SPIKES LONG, SQUARISH, DENSE AND PILOSE WHITE WITH PURPLISH TINGE, GLUMES KULED TO THE BASE. AWNS 4″ TO 5″ LONG.	
Hard Wheat.	
Grain, long, red	
Bulandshahr, Barha	

NOTE.—Glabrous used in comparative sense only. Pilose—hairs long simple, but rather thickly thinly sprinkled Light straw colour, used with some license in connection with bran.

Note on Indian wheats in Bengal.

1. Main types and their native names :—

	VERNACULAR NAMES.
Gam	Bengal Proper.
Gehum	North Bihar.
Gohun	West „
Gahum	East „

FOUR RACES.	COMMONEST NAMES.
I. Soft white	*Dudhia* or *Daud.*
II. „ red	*Jamali.*
III. Hard white	*Gangajali.*
IV. „ red	*Kheri.*

III and IV are cultivated only to a very limited extent, especially III or *gangajali.*

There is a good deal of confusion about the names. The name *gangajali*, for instance, applied to hard white wheat in the Sonthal Parganas, Bankura, Malda and Murshidabad, is used in Nadia for soft red wheat (II), and in Purnea and Rajshahi to hard red wheat (IV). Again soft red wheat is known in Tirhoot as *hara* and *harhura* and in Patna as *harha*, but these names are also applied in the same localities to hard red wheat. In these places the name *Jamalkhani*, which is only another form of *Jamali*, is applied to soft white wheat which is known in Patna, Gaya, South Bhagalpur, Palamau, etc., as *dudhia* or *daudi*. Other confusions need not be given in detail. It will be more useful, perhaps, to give the different names applied to the different types of wheat in the various parts of the Province :—

I.—SOFT WHITE.

Cultivation does not extend so far to the east as that of soft red (II) below.

Daudi.—Patna, Gaya, Palamau, Ranchi, Chapra.
Dudhia.—Monghyr, South Bhagalpur, the Sonthal Parganas, Birbhum, Bankura, Nadia.
Jamalkheri.—Champaran, Muzaffarpur, Darbhanga.
Mudalia.—Palamau (probably a bald or beardless variety).
Baragahuma.—Monghyr.

II.—SOFT RED.

Most largely cultivated in the Province.

Jamali.—Bhagalpur, Monghyr, Sonthal Parganas, Bankura, Birbhum.
Bargehuma.— } Gaya.
Kewalka.— } Gaya.
Champapuri.— } Gaya.
Lalka.—Shahabad, South-West Tirhut, South Monghyr, Hazaribagh.
Hara.— } Muzaffarpur, Champaran, Chapra, Darbhanga.
Hadda.— } Muzaffarpur, Champaran, Chapra, Darbhanga.
Harbara.— } Muzaffarpur, Champaran, Chapra, Darbhanga.
Gangajali.—Nadia.
Magia.—Patna and Bankura—an early ripening sub-race of II.
Piusa.—Patna.
Pirajome.—Saran. } A small grained sub-race of II.
Gatia.—Rajshahi. } A small grained sub-race of II.

III.—HARD WHITE.

Both III and IV are not much cultivated in Bihar, III being particularly scarce.

Gangajali.—The Sonthal Parganas, Bankura, Murshidbad, and Malda. (Also known as *Jamaliali* and *Shone Tikli* in Malda.)
Hara.—Purnea.

IV.—Hard Red.

Kheri.—Malda, Rajshahi, Pabna, Murshidabad, Nadia and Birbhum.
Gangajali.—Purnea, Rajshahi. Also called Naubia in Purnea.
Piuti.—Rajshahi.
Kazlia.—Rajshahi (Nattore)—a large grained sub-race.

INTERMEDIATE FORMS.

Between I and II.

Champapuri.—Darbhanga.

Between II and IV.

Hard red but rounded in form like soft red.
Shah Bagan.—Champaran.
Lali or Hara.—Muzaffarpur.
Hara.—Darbhanga.

Mixed varieties (I and IV).

Dogla.—Tirhut.

The raiyats simply go by colour and call thin wheat *dudhia* (*i.e.*, white) and *lal* or *lalka* (*i.e.*, red). Intermediate or mixed sorts are called *jamali* though this name generally implies a soft red kind. The grain dealers also classify wheats by the places of production. Thus *magahi* or *magaha* wheat means that grown in South Bihar though it may be white or red. As a matter of fact *magahi* wheat is generally either soft white (*duahia*) or hard red (*lal*). A white hard *magahi* wheat is also known and is locally valued most of all, but this is also called *dudhia* if it has any special name. It is rarely found in the market excepting immediately after the harvest, being generally bought up by local rich men from the village threshing ground. Mixed sorts are generally called in the market *panch katia.* Hard red is also sometimes called *jamali,* and the name *gangajali* is also sometimes applied to hard white and sometimes to mixed sorts. There is a good deal of confusion about the names. On the whole, however, one may say *dudhia* is almost always white, and *lal, lalka* or *jamali* is always red, either soft or hard. *Gangajali* is always hard and generally red. *Harha* or *Kathia* is always hard red.

Dudhia is generally grown on lighter soils under canal irrigation. *Lal* is grown on heavier soils without irrigation. *Dudhia* is also grown on heavier soils, but on lighter soils it gives a very poor yield without watering. *Lal* is more prolific than *dudhia* but the latter fetches a better price in the market. (See further below under head 4.)

All varieties are equally liable to rust, an irrigated crop more so than an unirrigated one.

Dudhia is in greatest demand for export, soft red is also very largely exported. The latter is said to give a whiter flour than the former; soft varieties generally are said to give a larger percentage of bran than the hard ones. The hard varieties are in greatest request for local consumption. They are considered both more palatable and nourishing than the soft varieties. Hard white as already mentioned is rare. But hard red used to be exported pretty largely to French and Italian ports for making macaroni. Enquiry in the Calcutta market shows that its export has lately much fallen off.

2. *Uniformity of samples.*—The raiyats try to keep their wheats pure, as *dudhia* or *lal.* But they get mixed up a little in the village threshing ground (*khalihan*) where the entire village brings its wheat after harvesting. The grain dealers also keep their wheats separate. As for dirt, the middlemen are largely responsible for it.

3. *Source of seed for sowing.*—The big raiyats always keep their own seed. The small men usually get their seed from the village *Mahajan,* generally himself a large farmer. They also occasionally buy it from the bazar. It is alleged that soft white wheat (*daudi*) sown on clay soil turns largely red in a few years.

4. *Rotation and Irrigation.*—Wheat is generally sown mixed with gram and a little linseed. After 2 or 3 years a crop of peas is taken. The land is generally left fallow during the monsoon and in South Bihar and Chota Nagpur rain water is bunded up for saturating the soil. The water is let off in September and the land prepared for sowing. Such land is called *choumas*. In North Bihar the practice of storing water is not known; but here, too, the land is usually left fallow during the rains. Sometimes wheat is preceded by maize or aus paddy during the monsoon. The lighter land which is used for *dudhia* wheat is not retentive of moisture and requires one or two irrigations. The heavier soil on which *lalka* or red wheat is grown can do without any watering. The question is not so much of the kind of wheat grown as of the kind of soil used. *Dudhia* has thus come to be grown close to the canals where irrigation is easy. It may, however, be mentioned that wherever a canal distributary has been made, wheat itself has in a large measure given way to paddy—a safer and more profitable crop.

5. *Threshing and winnowing.*—The dirt and other foreign matters found in Indian wheat are generally added by middlemen afterwards.

6. *Percentage of refraction in Indian wheat* varies according to the Bengal Chamber of Commerce from 2 per cent. to 10 or 12 per cent., the average being from 3 to 7 per cent.

7. *Percentage of wheat exported to wheat grown during the last five years.*—See table at the end.

8. *Damage to grain by weevils.*—Soft wheat is more attacked. The raiyats keep their wheat in pits lined with wheat straw. A circular hole is made in the earth either inside or outside the house. Linseed stems and straw are placed upon the bottom and sides about 15″ thick and the wheat, gram and other seeds are put in, being separated from each other by a layer of linseed stems and straw. The top is also covered with the same materials over which is put 2 or 3 feet of earth. Thus stored the grains keep perfectly good till next sowing season. The weeviling in exported wheat depends according to the Bengal Chamber of Commerce on circumstances and no estimate can be given.

9. *Port of shipment for exported wheat.*—Calcutta.

10. *Experiments on wheat improvement.*—(*a*) Wheat experiments are going on at Dumraon and Sripur Farms. The area under wheat experiment at Dumraon is a little over 4 acres.

(*b*) *General nature of the wheat experiments.*—A comparison of varieties and a comparison of the effects of different manures including green manuring are proceeding both at Sripur and Dumraon. The effects of heavy and light irrigation on wheat are also being tested at Dumraon and the merits of drill sowing *versus* broadcasting are being investigated at Sripur.

(*c*) *Methods adopted in improving wheats.*—None.

(*d*) *Results of introducing new varieties of wheat.*—About 12 or 13 years ago the Dumraon Raj distributed about 1,000 maunds of Muzaffarnagar wheat among its tenants in the Shahabad and adjoining districts. This wheat is still under cultivation in the Buxar Sub-Division and other parts. Unlike Sassaram wheat which introduced into Buxar is said to turn red, this Muzaffarnagar wheat has not changed colour yet; it is very prolific and stands the hot winds of March better than the local varieties.

(*e*) (*f*) and (*g*). Some 50 maunds of Muzaffarnagar wheat were distributed last year by the department to all the important wheat-growing districts of the Province. The wheat was distributed to the raiyats and others through Collectors and Managers of Wards Estates. Over and above its well established reputation, this variety has been found to give very good results at Dumraon. The exceptionally severe cold of winter last year, however, was not favourable to this experiment. This year about 70 maunds of this seed has again been distributed. It is too early yet to speak of results.

11. No Australian or other wheats have been introduced into the Province.

12. As for the introduction of good wheats from other Provinces see above about Muzaffarnagar wheat.

13. The results of the experiments in the Dumraon Farm are published every year in English. The wheat experiments do not form the subject of any separate report. The Sripur Farm results have not yet been published.

Sea-borne export of Bengal wheat to Foreign countries during the quinquennial period ending 1904-1905.

Year.	Wheat.	Flour.		Total of columns 2 and 4.	Remarks.
		Flour.	* Flour converted into wheat.		
1	2	3	4	5	6
	Tons.	Tons.	Tons.	Tons.	
1900-01	1,200	162,754	217,005	217,205	* Out of 4 seers of wheat generally 3 seers flour is obtained.
1901-02	3,260	153,481	204,641	207,901	
1902-03	52,649	385,603	514,144	566,793	
1903-04	241,611	525,727	699,636	941,277	
1904 05	432,334	763,683	1,018,244	1,450,578	

Wheat produced in Bengal from 1900-01 to 1904-05—

Year.	Yield in tons.
1900-01	472,600
1901-02	391,500
1902-03	485,900
1903-04	527,800
1904-05	444,100

D. N. MOOKERJI,

Assistant Director of Agriculture, Bengal.

Madras.

The area (about 20,000 acres reported) on which wheat is sown in this Presidency is so small, both relatively to the crop grown in other parts of the Empire (20,000,000 acres) and also to the area of other crops grown in the Presidency, that it is of no practical importance here. It is only in the Deccan Districts, Salem and Coimbatore, and on the Hills that the crop is grown at all and nowhere in any of these districts can it be regarded as at all important. What is grown is raised for local consumption and in the Deccan Districts it is regarded as one of the most precarious crops and is one that is only taken as a catch crop under peculiar circumstances.

There is nothing to indicate that the crop deserves special attention in this part of India and hitherto it has received none except a not very well advised attempt to introduce English wheats on the Nilgiris some 18 years ago and some not very successful attempts to introduce wheat obtained from the Central Provinces on the lower hill ranges of the Salem district in later years.

This being so it does not appear that Madras is specially interested in Indian wheat.

C. BENSON,

Deputy Director of Agriculture, Madras.

Punjab.

Varieties of Punjab wheat.—Some three years ago my predecessor, Mr. Sykes, obtained samples of all reputed local varieties of Punjab wheat from each district in the Province—72 samples were collected. These have been sown side by side and observed by the Manager of the Lyallpur Farm and by me in successive harvests. A tentative classification into eight actual distinct varieties has been made by the Manager, and this is embodied in Statement I. The wheats were seen last spring by Mr. Leake who has kindly promised to send me a report on the specimens with which he was supplied. The final clasification awaits the attention of an English specialist. It will be noticed that in some

cases the Manager has placed red and white grains in the same class. It will doubtless be necessary to sub-divide these although the outward appearance of the plants is the same. Heads of the main varieties with specimens of the grain are forwarded in a box.

The hard red wheats are most in favour for local consumption as they contain more gluten. White wheats are used in making confectionery. A large proportion of the wheats are Macaroni wheats and are actually shipped when exported to Mediterranean ports. But it is impossible to speak with authority on this point pending the final classification.

2. *Are the varieties grown of distinct type or is the crop mixed.*—Some varieties, such as the Wadanaks (large grained wheat on manured well lands), Ghoni of Leiah, and soft red (on dry lands in the North-West) are grown pure. Apart from these there is almost always some proportion of admixture. With a good cultivator this will be small, with a bad cultivator large. I am informed that there has been an improvement in the purity of the samples in Lyallpur in response to a demand for this, backed up by better prices for freedom from admixture. The following table prepared by the Manager of the Lyallpur Farm is fairly correct for average samples:—

Name by which the variety is known commercially.	Mixture of grains.	Percentage of each.	Remarks.
Soft white	Soft white	55	
	Hard white	30	
	Red	13	
	Other seeds (Barley, etc.)	2	
Hard white	Hard white	75	
	Soft white	10	
	Red	13	
	Other seeds (Barley, etc)	2	
Red soft	Red soft	55	
	Red hard	30	
	White	2	
	Other seeds (Barley, etc.)	3	
Red hard	Red hard	75	
	Red soft	20	
	White	2	
	Other grains (Barley, etc.)	3	

3. *Source of seed for sowing.*—This question can only be answered in general terms. Good cultivators and well-to-do cultivators keep their own seed. Bad cultivators, tenants-at-will and persons in reduced circumstances will ordinarily buy or borrow seed usually of inferior quality from their grain-dealer or money-lender. Where there is irrigation and the soil is of good quality, the cultivator being assured of his crop and of a return for his industry, has an incentive to exertion. In tracts which are very insecure, the cultivator's attitude can be easily understood.

4. *Principal rotations on wheat land*—(*i*) *Irrigated land*—

(*a*) Wheat follows wheat for a succession of years. Eventually a kharif crop is grown and then the land lies fallow for a year.

(*b*) On rich manured well lands we find wheat followed by maize for a number of years.

(*c*) As a two years' course we have wheat-cotton and a quick-maturing crop, such as *China* or tobacco or a fallow.

(*d*) Wheat, indigo, wheat, indigo, and so on in the area where indigo is grown.

(*ii*) *Unirrigated land*—

(*a*) Wheat after wheat for a succession of years and then a whole year's fallow.

(*b*) Wheat followed by maize, cotton, *bajra* or *jowar*, and then a year's fallow.

5. Threshing and winnowing.

6. Usual percentage of refraction in exported wheats.

The large percentage of dirt and other seeds in exported wheat is not due to the method of threshing and winnowing, but to the trade custom which allows for a fixed percentage of admixture. Most of the admixture is added by the exporters, or by their agents, or by the middlemen who purchase from the cultivators. The cultivator claims that he markets his wheat with the minimum of foreign matter. The lowest lying portion of the grain after winnowing contains most of the dust, and is the perquisite of the menials employed on this work. It is never sold for export. Wheat can be supplied by the growers with not more than 1 or 1½ per cent. of dust and it is admitted by most of the trade that it is brought in with less than 2 per cent. I believe that the practice is generally for the merchant to buy clean wheat and appropriate for himself a margin of profit on the operation of admixture. The remedy for the present deplorable state of affairs is for the English and Continental buyers to penalise impure wheat and pay for the clean article. I do not know how far it is true that there exists a wheat cleaning industry, the interests of which would be opposed to change. While on this subject I may mention the reprehensible practice of watering wheat immediately before sales to add to its weight. In some cases this has led, I believe, to a serious deterioration in large shipments. I understand that the various exporting firms are alive to this danger and are taking steps to meet it.

7. The percentage of wheat exported to wheat grown in the last five seasons appears from the following table:—

Year.	Wheat grown in tons.	Wheat exported in tons.	Percentage.
1900-01	2,636,683	623,982	23
1901-02	1,846,332	535,828	29
1902-03	2,314,714	870,127	37
1903-04	3,076,161	1,190,608	38
1904-05	2,855,353	.....	.....

8. *Damage done by weevils.*—Weevils do not apparently do any great amount of damage if proper precautions are taken. Grain for consumption is usually kept in large earthen bins, which for the first year or two are fairly secure and are renewed every three or four years. Grain when in large quantities is best stored in a well ventilated room with burnt brick walls and floor. Sand or wheat chaff, the latter being the better, is laid 1 or 2 feet deep at the bottom, the walls being lined with grass matting. A layer of bhusa (wheat chaff) is also placed on top of the wheat if in bulk. The old practice of keeping grain in pits is still in vogue to some extent, but is being displaced by house storage. Pits are lined with wheat chaff and are closed over. Wheat kept in pits is apt to deteriorate after about a year. It turns a dark colour and the flour falls off in quality and flavour owing to fermentation. The remedy is to take out the grain and air it as soon as deterioration makes itself apparent. Grain which has been exposed to rain on the threshing floor is always more susceptible to weevil attack. It is the practice to air and dry wheat in the sun when the rainy season is over as a precaution against damp.

9. The port of shipment for exported wheats is Karachi.

10. Experiments on wheat improvement—

(*a*) Experiments have been conducted during the last four years at the Lyallpur Farm. There are now some 50 acres under wheat at Lyallpur. Besides this, some 250 acres are under wheat for seed distribution in the Sargodha Seed Farm.

(*b*) A variety experiment at Lyallpur aims at the discovery and improvement of the indigenous and Australian varieties, best suited to the Chenab Colony and surrounding districts. There are also manurial, hydraulic, seed-rate and rust experiments.

(*c*) Hybridisation has been done to a certain extent on lines suggested by Mr. Mollison, but we can make no progress until we have the services of an Economic Botanist. Selection has been done by sifting and by careful handpicking. A special selection is made every year.

(*d*) It cannot be said that any variety has been introduced up to the present, but prospects are hopeful in the case of Australian No. 27 which has shown good qualities and has borne consistently well. Muzaffernagar suffered severely in the severe frosts of last winter, but a fresh supply of seed wheat has been imported.

(*e*) The test applied to wheats is observation for several years on the Lyallpur Farm and a preliminary issue to selected men who report on the results.

To sum up, the important questions connected with wheat in the Punjab are :—

(*i*) The introduction, if possible, of improved varieties and the improvement of existing varieties.

(*ii*) The abolition of the existing practice of adding dirt and inferior grain before export.

(*iii*) The abolition of the existing practice of watering grain before export.

(*i*) is receiving the attention of the Agricultural Department. But (*ii*) and (*iii*) are matters which the trade alone can remedy. The trade also has it in its power to encourage, effectually, the cultivation of varieties pure, and of high class wheats, by the establishment of an active demand. Rust is very rarely the cause of serious loss.

W. RENOUF, I.C.S,
Director of Agriculture.

Number of group.	Number of variety.	Description of grain.	Native name.	Whether grown on irrigated or unirrigated land and method of irrigation.	Liability to rust.	Whether grown mainly for export or home consumption.	Description of plant			Remarks.
							Height of the plant in feet.	Head.	Straw.	
1	2	3	4	5	6	7	8	9	10	11
I	32	White soft	Ghoni of Lahore	Generally irrigated (by well or by canal).	Slight	Mainly for export	3½—4	White bearded.	Good	Soil—Wadanaks are usually grown on rich soils Hard red varieties suited to dry lands. Others are intermediate.
	44	Do.	Daud Khani of Dasmya	Do.	Do.	Do.	3—3½	Do.	Do.	
	47	Do.	Safed of Ludhiana	Do.	Do.	Do.	3½—4	Do.	Do.	
	48	Do.	Safed of Rohtak	Do.	Do.	Do.	3½—3½	Do.	Do.	
	49	Do.	Safed of Batala	Do.	Do.	Do.	3—3½	Do.	Do.	
	52	Do.	Daud Khani of Dehli	Do.	Moderate	Do.	3—4½	Do.	Do.	
	70	Do.	Pori of Montgomery	Do.	Slight	Do.	3½—4	Do.	Do.	
	1	Red soft	Lal of Karnal	Do.	Moderate	Partly for local consumption and partly for export.	3½—4	Do.	Do.	
	3	Do.	Lal of Attock	Do.	Slight	Do.	3—4½	Do.	Do.	
	5	Do.	Lal of Zira	Do.	Do.	Do.	3½—4	Do.	Do.	
	6	Do.	Kasulu or Surkh of Ferozepore	Do.	Moderate	Do.	3½—4	Do.	Do.	
	7	Do.	Rotti or Lal of P. D. Khan	Do.	Slight	Do.	3—4	Do.	Do.	
	8	Do.	Lal of Ludhiana	Do.	Moderate	Do.	3½—4	Do.	Do.	
	10	Do.	Lal Desi of Jhelum	Do.	Do.	Do.	3—4	Do.	Do.	
	11	Do.	Lal of Rawalpindi	Do.	Slight	Do.	3—3½	Do.	Do.	
	13	Do.	Lal of Dehli	Do.	Do.	Do.	3—4½	Do.	Do.	
	2	Red hard	Lal of Sialkot	Generally unirrigated	Do.	Mainly for local consumption.	3½—4½	Do.	Do.	
	4	Do.	Lal safed of Sirsa	Do.	Do.	Do.	3½—4	Do.	Do.	
	9	Do.	Desi Surkh of Jallandur	Do.	Do.	Do.	2½—3½	Do.	Do.	
	26	Do.	Watni of Shahpur	Do.	Do.	Do.	3½—4½	Do.	Do.	

Classification of Punjab Wheats—contd.

Number of group.	Number of variety.	Description of grain.	Native name.	Whether grown on irrigated or unirrigated land and method of irrigation.	Liability to rust.	Whether grown mainly for export or home consumption	Description of plant.			Remarks.
							Height of the plant in feet.	Head.	Straw.	
1	2	3	4	5	6	7	8	9	10	11
	65	Red hard	Kunjhori of Muzaffargarh	Generally unirrigated	Slight	Mainly for local consumption.	3½—4½	White bearded.	Good	
	67	Do.	Kunjhori of Multan	Do.	Do.	Do.	3½—4½	Do.	Do.	
II	29	White soft	Safed of Moga	Generally irrigated (by well or by canal)	Do.	Mainly for export	3—3½	Red bearded.	Do.	
	50	Do.	Safed of Amritsar	Do.	Do.	Do.	3½—4	Do.	Do.	
	56	Do.	Soban of Chiniot	Do.	Moderate	Do.	3½—4½	Do.	Do.	
	58	Do.	Jogia of Karnal	Do.	Slight	Do.	3—3½	Do.	Do.	
	66	Do	Kunjhori of D. G. Khan	Do.	Somewhat	Do.	3½—4½	Do.	Do.	
	30	White hard	Rangrih of Palampur	Do.	Slight	Do.	3½—4	Do.	Do.	
III	...	White soft	Ferozepore Wadanak (Show)	Always irrigated (generally by well). Frequently manured.	More liable than the rest.	Mainly for local consumption.	4—5½	Long bearded. Awns some rather dark.	Coarse.	
	14	Do.	Wadanak of Zira	Do.	Do.	Do.	4—5	Grain long	Do.	
	15	Do.	Wadanak of Sialkot	Do.	Do.	Do.	4½—5½	Do.	Do.	
	16	Do	Wadanak of Batala	Do.	Do.	Do.	4½—5½	Do.	Do.	
	18	Do.	Wadanak of Amritsar	Do.	Do.	Do.	4—5½	Do.	Do.	
	19	Do	Dagar of P. D. Khan	Do.	Do.	Do.	4—5	Do.	Do.	
	20	Do.	Dagar of Wazirabad	Do.	Do.	Do.	4½—5½	Do.	Do.	
	21	Do.	Dagar of Shahpur	Do.	Do.	Do.	3½—5½	Do.	Do.	
	23	Do.	Pamman of Muzaffargarh	Do.	Do.	Do.	4½—5	Do.	Do.	
	24	Do	Pamman of Multan	Do.	Do.	Do.	4—5½	Do.	Do	
	25	Do.	Pamman of Montgomery	Do.	Do.	Do.	5½—5½	Do.	Do.	

	17	Red hard	Wadanak Kalhinghori of Montgomery.	Do.	Do.	Do.	4½—5	Do.	Do.
	22	Do	Pamman of Ferozepore	Do.	Do.	Do.	3½—5	Do.	Do.
IV	61	Red soft	Rotti of Montgomery	Always irrigated (by well or by canal).	Do.	Do.	3½—5	Slightly bearded with dark awns.	Do.
	12	Red hard	Lal of Batala	Do.	Do.	Do.	3½—4½	Do.	Do.
V	31	White hard	Koni of Chakwal	Generally irrigated	Slight	Mainly for export	2½—4½	Beardless white.	Good.
	53	Do	Kunj of Muzaffargarh	Do.	Moderate	Do.	3½—4½	Do.	Do.
VI	40	Do	Rodi of Montgomery	Do.	Do.	Do.	3—4	Beardless Reddish white	Do.
	54	White soft	Kanku of Gujrat	Do.	Slight	Do.	3½—4½	Do.	Do.
VII	35	Do	Ghoni of Chiniot	Both on irrigated and unirrigated land.	Moderate	Do.	4—4½	Do.	Do.
	46	Do	Kanku of Palampur	Do.	Do.	Do.	3½—5	Do.	Do.
	60	White hard	Rotti of Muzaffargarh	Do.	Do.	Do.	3½—4	Do.	Do.
	27	Do	Rodi of Attock	Do.	Do.	Do.	3½—4½	Do.	Do.
	28	Do	Ghoni of Gujrat	Do.	Do.	Do.	4—4½	Do.	Do.
	33	Do	Ghoni of Sialkot	Do.	Do.	Do.	4—4½	Do.	Do.
	34	Do	Koni of Jhelum	Do.	Do.	Do.	4½—5½	Do.	Do.
	36	Do	Ghoni of Amritsar	Do.	Slight	Do.	4½—4½	Do.	Do.
	37	Do	Koni of Batala	Do.	Moderate	o.	4½—4½	Do.	Do.
	38	Do	Rodi of Muzaffargarh	Do.	Do.	Do.	3½—5	Do.	Do
	41	Do	Mundi of Karnal	Do.	Do.	Do.	3½—4	Do.	Do.
	42	Do	Mundi of Jullundur	Do.	Do.	Do.	3—5	Do.	Do.
	43	Do	Wadanak of Ludhiana	Do.	Slight	Do.	3—4	Do.	Do.
	45	Do	Safed of Lahore	Do.	Do.	Do.	3½—4½	Do.	Do.
	51	Do	Jhakrahar of Palampur	Do.	Moderate	Do.	3—5	Do.	Do.
	55	Do	Kanku of Dasuya	Do.	Do.	Do.	4—5	Do.	Do.
	57	Do	Safed Brij Sondha of Rohtak	Do.	Do.	Do.	2½—4	Do.	Do.
	68	Do	Jogia of Karnal	Do.	Do.	Do.	4—5	Do.	Do.
	71	Do	Suthra of Multan	Do.	Do.	Do.	4½—5	Do.	Do.

Classification of Punjab Wheats—concld.

Number of group.	Number of variety.	Description of grain.	Native name.	Whether grown on irrigated or unirrigated land and method of irrigation	Liability to rust.	Whether grown mainly for export or home consumption.	Description of plant.			Remarks.
							Height of the plant in feet.	Head.	Straw.	
1	2	3	4	5	6	7	8	9	10	11
VIII	72	White soft	Makkawali of D. G. Khan	Generally unirrigated	Moderate	Mainly for local consumption.	3—3½	Beardless with compact small round grains.	Rather coarse.	
	39	White hard	Rodi of Shahpur	Do.	Slight	Do.	3—3½	Do.	Do.	
	59	Do.	Rangrih or Ghiali of Kangra	Do.	Moderate	Do.	3½—4	Do.	Do.	
	63	Do.	Makini of Multan	Do.	Slight	Do.	3—3½	Do.	Do.	
	64	Do.	Dodi of Muzaffargarh	Do.	Moderate	Do.	3—3½	Beardless with small round grains.	Do.	
	69	Do.	Daudan of Multan	Do.	Slight	Do.	3—4	Do.	Do.	
	62	Red hard	Makhi of Chiniot	Do.	Moderate	Do.	3—3½	Do.	Do	

Burma.

Questions 1—5.—Wheat is of very little importance in Burma generally. The statement below gives the areas cultivated :—

Areas in 1904.

District.	Acres.	District	Acres.	District.	Acres.
Henzada . .	2	Pakokku . .	300	Minbu . .	2,140
Mandalay . .	3,472	Shwebo . .	483	Sagain . .	20,791
Lower Chindwin .	1,255	Meiktila . .	970	Yamethin . .	29
Kyaukse . .	4,220	Myingyan .	259	...	...

Areas in 1905.

District.	Acres.	District.	Acres.	District.	Acres.
Pakokku . .	320	Minbu . .	2,378	Mandalay . .	1,008
Shwebo . .	625	Sagaing . .	20,805	Lower Chindwin	1,061
Kyaukse . .	3,083	Meiktila .	971	Yamethin .	91
Myingyan . .	234				

	Acres.
Total areas 1904	33,921
„ „ 1905	30,631

The area grown in 1903 was 19,883 acres only.

An account is given below of the methods of cultivation in Sagaing where wheat is grown on land very similar to the *kanhar* of the Central Provinces, and in Minbu where it is grown on alluvial land (island formations in the Irrawaddy).

Minbu—

(1) Sown November, reaped April.
(2) 2½ baskets of seed per acre.
(3) Requires a loamy soil with a minimum of sand in it and an overlayer of silt, the deeper the better, in annually submerged lands.
(4) Not manured nor irrigated.
(5) Only one crop in the year.
(6) It must be sown when rains are over as a shower of rain kills young crop.
(7) Land must be ploughed to a powder before the seed is sown. It is generally ploughed before the river rises and again carefully when sowing is about to take place.
(8) Seed when sown is covered with a layer of soil.
(9) Crop likes the sun. A succession of cloudy days will injure it and help to develop 'thanyaung'—rust.
(10) It is a paying uncertain crop and the labour of preparing ground is hard.
(11) Greatest enemy rust.

In the Settlement Report of 1897 it is recorded that the crop suffered from rust for three successive years:—

Rates, old	1892-93.	1893-94.	1894-95.
	R. a.	R. a.	R. a.
	3 8	3 8	3 8

Assumed outturn, 8 baskets.

Sagaing.—Grown on level, rich, black clayey soil (sanè). Only met with in certain well-defined areas. Lying low and being level and retentive of moisture, much of it is too wet for successful cultivation during the middle of the rains. Towards the end of October part is sown with gram and in November a larger area with wheat. The latter, which is always of bearded variety, ripens first from beginning of March. Wheat lands are not usually fallowed nor is any regular rotation practised. It is said gram can be grown in successive years, but not to thrive well if sown more often than once in 4, 7 or even 9 years. Therefore it is usual for any given field to be under wheat for a considerable number of years in succession and under gram for only one year at long intervals. In some localities wheat cultivation has been practised for several generations; it has, however, materially extended during the past 10 years and is still on the increase. There were only about 14,000 acres in 1893-94.

Questions 6—13.—No export of wheat from Burma and no experiments.

Central Provinces.

1. Soft red and soft white require the best class of soil such as *kabar*, *kanhar*, etc., which retain moisture for a longer period than *morund* and other yellow soils. Soft white and soft red varieties are late and therefore require moisture for a longer period. Hard white and hard red are earlier and less dependent on a continuous supply of moisture.

Irrigation.—If there be means of irrigation all wheats can be irrigated should the winter showers fail. The methods of irrigation are two:—(1) Kiari, (2) Flooding. The former is followed if there be scarcity of water, and the latter when the water is plenty.

Liability to rust.—Soft white is the variety which is most liable to rust; while next to it in order comes soft red, hard white and hard red.

Order of importance as regards area cultivated, viz.:—1st—Soft white. 2nd—Soft red. 3rd—Hard white. 4th—Hard red.

For export.—Soft white is the most important, but for local use hard white comes first.

2. Soft white is generally grown as a pure crop; while in soft red there is sometimes a mixture of other types. Hard white is generally grown mixed with other varieties.

3. Some well-to-do ryots save their own seed, but the poorer peasants are dependent for their supplies on the grain dealer, who is also generally a money-lender. He charges an exhorbitant interest on his loans, takes over a great portion of the produce of their land in payment of their debts, sells the best of the wheat thus obtained for consumption, and supplies the poor peasants with the inferior quality which he has left. The seed used by these poor cultivators, therefore, instead of being improved from year to year by selection, is really deteriorating in quality.

4. In Bandhias which hold water, wheat follows early rice. In *kanhar* and *kabar* soils wheat and gram as a mixture are grown year after year, which serves the purpose of rotation. In *morund* and certain other classes of soils kharif and rabi crops are rotated in places where wheat can be grown. Generally, where they have a rotation, wheat is grown after gram, masur (*Ervum lens*) or teora (*Lathyrus sativus*).

5. The presence of dirt and other seeds in wheat is due partly to the crude Indian method of winnowing and partly to the dishonest practices of some grain merchants, who add a certain percentage of small stones and earth to the grain.

6. Exported wheat contains about 5 per cent. impurities.

7. Percentage of wheat exported to wheat grown during the last five years :—

	Maunds.
1900-01	415,890
1901-02	915,979
1902-03	1,968,092
1903-04	4,254,579
1904-05	3,819,470
Total	11,374,010

Yield during the last five years was :—

	Tons.
1900-01	440,909
1901-02	571,040
1902-03	666,589
1903-04	751,388
1904-05	760,647
Total	3,190,573

The percentage of wheat exported to wheat grown during the last five years is therefore 13 per cent.

8. Exported wheat is seldom weeviled, as it is exported when still quite fresh or after having been safely stored in *Bandas*. But when stored for local consumption or for sowing, it is often badly damaged by weevils unless protected by these *Bandas*. Sometimes it is stored in bamboo Dholis (bins) until the time of sowing. Where these bins are used, the wheat inside is mixed with *bhusa*, while on the outside the bin is carefully cemented with a layer of cow-dung and clay.

9. Bombay and Calcutta.

10. (*a*) Nagpur, Raipur, Hoshangabad Experimental Farms—

Nagpur	7·00
Hoshangabad	25·00
Raipur	3·50

(*b*) The general nature of the experiments in wheat cultivation has been to test the effects of different manures, different rotations, different modes of tillage and of growing it as a mixed crop.

(*c*) By both selection and hybridization.

(*d*) The attempt to grow the exotic varieties on the Nagpur Experimental Farm has met with but little success. The Australian wheats, for instance, when tried there, were found to be more subject to drought and rust than indigenous varieties. Being late, the soil drys before they reach maturity and their growth is thus checked. In most cases these foreign varieties give good results where irrigated, but some of the types are so late that even though irrigated and allowed to occupy the ground for six months, no good ears were formed. Wheats from other Indian Provinces are successful to a certain extent in the Nerbudda Valley, but not so in the Nagpur country, as they thrive better under irrigation or in retentive soil.

(*e*) Foreign varieties were, therefore, unsatisfactory, and have not been distributed among cultivators.

(*f*) The wheat which has been found to be most rust-resistant is the cross that was effected on the Experimental Farm between two varieties, haura (hard white) and mundia (soft red). This seed is now distributed every year to cultivators through the Agricultural Associations.

(*g*) Revenue Officers, members of the Agricultural Associations, Deputy Commissioners and Agricultural experts watch the results as far as possible and they are discussed at the meetings of District Agricultural and Industrial Associations,

11. To no extent in these Provinces.
12. Information not available.
13. (*a*) Annual Reports of Farms.
    (*b*) Leaflets in Hindi and Marathi.

List of Central Provinces varieties of wheats classified.

Hard red—
(1) Katha.
(2) Sambalpur wheat.
(3) Bangasia.
(4) Ekdania.
(5) Katha (white ears) when ripe.
(6) Juaria, Jondhla or Dhania.

Hard white—
(1) Jalalia (white ears).
(2) Jalalia (red ears when ripe).
(3) Bansi (black awns when ripe).
(4) Bansi (white awns when ripe).
(5) Haura.
(6) Daudkhani.

Soft white—
(1) Pissi-white.
(2) Mundi pissi.
(3) Sukaria.
(4) Hybrid (Mundi and Haura).

Soft red—
(1) Lal pissi.

* * * *

EASTERN BENGAL AND ASSAM.

I regret I am unable to furnish a note on wheat cultivation, as I have very little information concerning this subject at my disposal, so far as Eastern Bengal is concerned. In Assam, the cultivation of wheat is practically unknown except in a small tract in the Goalpara district adjoining Eastern Bengal. Experiments have been made in recent years to introduce wheat cultivation in Assam, and they are being continued. Most of the experiments have proved unsuccessful, but there is reason to believe that wheat may be successfully cultivated in Lower Assam.

H. C. BARNES, *I. C. S.*,
Director of Agriculture.

MYSORE.

Wheat is grown still less than tobacco; the average area for the past 17 years being given as 3,409 or not quite ·06 per cent. of the arable land under crop. Although the area varies considerably from year to year no definite or clear increase or decrease can be noticed. By far the greatest part of the crop is grown in a district of the State of which I have seen very little, and I know as yet practically nothing of wheat grown in Mysore. Some of the samples of wheat I have seen were small, shrivelled, hard and flinty, though a large proportion were very soft. They were all or nearly all of the red variety. None of the samples were to be at all compared with average or even poor Canadian wheat. But I cannot say that the samples I have seen truly represented the wheat grown in Mysore State.

A. LEHMANN, *PH. D.*,
Agricultural Chemist to the Government of Mysore

APPENDIX C.

NOTES ON THE IMPROVEMENT OF INDIAN TOBACCO.

Synopsis.

In writing a synopsis of the notes on tobacco I find myself at a considerable disadvantage. First, the late date on which some of the articles were received gave me but little time for preparation; secondly, the peculiar and diversified methods of the cultivation and curing of this crop in the different districts of India make it very difficult to draw up a synopsis with any pretence to uniformity. The information in some instances is given in vernacular terms, which are not understood, with no English equivalents; in others, important points are omitted, and in some cases references are made to literature which is not at hand. It must thus appear that considerable time would be required to do justice to the subject by reading up the references and presenting to the Board a consolidated and exhaustive statement. As I have already said, the late receipt of some of the articles has prevented my doing this. I have, therefore, thought it best to merely abridge the notes received under a few general heads, leaving the members to refer to the articles themselves for details. Out of a total area of 224,000,000 acres under crops in British India and Native States, 1,006,652 are under tobacco. This figure is probably under the mark, as has, at any rate, been pointed out by Mr. Benson in the case of Madras. No statistics are at hand to show the value of this crop, but if we take the figure of £5 or Rs. 75 per acre as the gross yield, we have a trade equal to over five million pounds sterling, which would bring it into the fifth or sixth position of importance among the crops of India. Its expansion would, however, be very considerable if tobacco could be grown in India fit for European consumption. Only seven papers have been received, *viz.*, from the Punjab, Madras, Bengal, United Provinces, Mysore and Behar, the only important omission being Bombay, with 72,000 acres, and the Central Provinces, with 17,000 acres.

Punjab.

I.—The area in the Punjab amounts to 58,818 acres and is slightly on the increase. It is grown mainly in the Central Punjab and submontane tracts.

II.—The varieties are all native kinds. A considerable portion of the Punjab crop, especially in the Lahore District, consists of the *Kandahári* kind. Other varieties are also cultivated, such as *Bághdádi*, *Noki*, *Sambii*, *Purbi* from Bengal, *Baingnani* and *Surati* from Surat. Some American varieties were introduced as an experiment, which however proved a failure.

III.—For cultivation we are referred to Watt's Dictionary, pages 403 and 404. The land is ploughed 8 or 10 times, dressed most carefully, and laid out in ridges some two inches high and eight inches apart, the seedlings being planted half way up the ridge on either side alternately and about eight inches apart. The crop is irrigated every 8 or 10 days till it is ready. The land is well manured. The use of salt wells is in vogue in the Punjab, as it is in many other districts in India, with remarkable results, and a thorough investigation into their use seems called for.

IV.—See notes by Mycologist and Entomologist for diseases and pests.

V.—All kinds of tobacco are prepared alike, by burying in a pit after drying for a couple of days or so, and left to ferment. The best leaves are tied into bundles, the rest are twisted into ropes.

VI.—The import and export trade is as follows, but no information is given as to markets:—

	Maunds.
1.—*Imports*—	
(*a*) Unmanufactured	48,812
(*b*) Manufactured	646
2.—*Exports*—	
(*a*) Unmanufactured	19,337
(*b*) Manufactured	53

Madras.

I.—The area under tobacco in Madras amounts to 115,100 acres. It has considerably increased during the last 20 years, the figures for 1885—1889 being 81,900 acres. Mr. Benson says, however, that the area is considerably greater than the figures show. The most important districts are:—

	Acres.
Kistna	28,500
Coimbatore	38,900
Godaveri	11,200
Kurnool	12,000

II.—As regards varieties, Mr. Benson remarks that there is little on record on this point. The two most important varieties grown in Dindigul (Coimbatore) are *Usi-Kappal* and *Wara-Kappal*, the former being *par excellence* the variety best suited for cigar manufacture. The names of other varieties are given, which are grown for either cigar, snuff or chewing. None of the known varieties suited for European consumption, such as Havana, Orinoko, Java, Sumatra, appear to be grown.

III.—A peculiarity in the cultivation of tobacco in Godaveri is that the young seedlings are often not planted out till they are 9 inches high, a custom which is opposite to that practised in any other parts of India, and indeed in any part of the world, for the usual thing is to plant the seedlings as young as possible. The roots are also cut before transplanting. The cultivation too appears to be very much less than is usually given to a tobacco crop. As a rule fallowing and heavy manuring and keeping the land clean and open before and during the cultivation of the crop, appear to be necessary in most parts, but in Godaveri "the land is left to grow up into a jungle of grass and weeds for half the year or more, and is then hastily prepared and planted with a delicate plant, and very little after cultivation is given to it." It appears too that the same land is cropped for several consecutive years. This tobacco is made into cigars, the quality of which is described as "execrable." In the Kistna and Kurnool districts, black cotton and mixed loamy soils are selected and the cultivation carried on more in accordance with approved methods. For the cultivation of tobacco in Coimbatore and around Dindigul reference has been made to Bulletin No. 53 of the Madras Department of Agriculture. It appears that careful cultivation is practised, and the two varieties *Usi-Kappal* and *Wara-Kappal* are preferentially grown, the former variety supplying the Trichinopoly cigar.

IV.—See notes by Mycologist and Entomologist.

V.—Regarding the curing of tobacco in Madras, it may be briefly stated that as regards the Godaveri, Kistna and Kurnool districts the methods do not materially differ from those used in India for tobacco for native consumption. That is to say, there is the usual drying in the sun on the ground and the curing in heaps. On the other hand, in parts of Coimbatore, where the tobacco is grown partly for European consumption, curing approximates somewhat to the American methods, but without any scientific control. Thus Mr. Benson writes: "In Coimbatore * * * * the leaves are not spread on the floor to dry as in Tinnevelly. They are suspended on poles for about three weeks, then removed and stacked for a few days; the bulk being opened at intervals of three days or so. The leaves are then stripped, bundled and stacked for about 40 days, the bulk being opened and rebulked once in 3 or 4 days."

VI.—The Madras trade divides itself under three heads:—

(1) Internal, to different parts of India.
(2) Coasting, to different parts of India.
(3) Foreign exports.

Of these the first two are the most important. The detail figures can be learnt from Mr. Benson's paper. The produce of the Godaveri and Kistna districts goes to Burma; Kurnool exports largely to Hyderabad, and Coimbatore supplies the Dindigul cheroots for European consumption and the demand from Malabar and the Straits. Burma and the Straits are the chief markets for Madras tobacco, and the bulk of this trade is in the form of unmanufactured leaf.

VII.—With regard to improvements, Mr. Benson says: "It cannot be said that any measures for the improvement of this crop have been taken within official memory. There have at times been efforts made, in a rather haphazard way, to introduce new varieties from abroad, but almost, if not entirely without success."

Bengal and Behar.

I.—The area under cultivation in Bengal amounts to 537,900 acres, or more than half that of the whole of India. It has shown no material increase in recent years; indeed the area in Purneah has apparently fallen off to some extent owing to bad prices and the competition with jute. The most important districts for tobacco are as under:—

	Acres.
Lower Bengal	59,300
Eastern „	374,900
Behar	75,700

II.—The Bengal varieties are all native kinds and their origin is obscure.

III.—There is nothing remarkable about the cultivation of tobacco in Bengal. It follows the ordinary methods and there is little difference in the different tracts. Fallowing, heavy manuring and a general high state of cultivation are in vogue. Topping is done when the plants attain a height of 12 or 15 inches, which gives a low, coarse plant with a few heavy leaves. In America plants are topped higher, leaves are more numerous and a fine texture of leaf is aimed at. The result is that the Bengal plant has developed into a coarse heavy plant unsuited to European consumption. These remarks do not refer to tobacco grown in Eastern Bengal, a large portion of which goes to Burma and some of which returns to Calcutta in the shape of Burma cigars. It is to be regretted that no * information has been supplied from this Province as its trade in tobacco is the most important in Bengal.

IV.—See notes by Mycologist and Entomologist.

V.—Leaving out reference to Eastern Bengal for want of information, there are apparently two ways of curing tobacco in Bengal. In Behar the drying is done in the sun, but in Jessore and Nadia it is done in the shade; both being sweated much in the usual way, but without any scientific control. Whether any difference in quality and price is obtained for the different treatments is not stated.

VI.—With regard to the tobacco trade in Bengal, it is known that the best of the Behar tobacco goes to the United Provinces and the worst to Lower Bengal, all being for native consumption. As regards the trend of the trade in Lower and Eastern Bengal, no information has been supplied, though the study of the * Eastern Bengal trade would without doubt be of the utmost interest.

VII.—As regards attempted improvements, the only ones worthy of consideration are the experiments carried on at Pusa some years ago, and those made by the writer at Dalsingserai in 1901 and 1902. It is to be regretted that reliable records are not obtainable on the Pusa experiments. They appear to have been unsuccessful for the following reasons:—

(*a*) difficulty in controlling the drying and sweating processes owing to the excessive dryness of the climate;
(*b*) the adherence of dust to the leaf, entailing the payment of custom duty thereon and injuring the quality of the leaf;
(*c*) the want of an adequate supply of organic manures;
(*d*) the possibility that the variety of plant best adapted to Behar was not being grown;

As regards the Dalsingserai experiments, they seem to have been a success from an agricultural point of view, that is to say, provided the most adaptable plant was selected, results obtained both in yield per acre and texture of leaf were most satisfactory. The drying and curing operations were not a success owing to the excessive dryness of climate, want of expert knowledge, and the want of properly constructed barns.

* The note for Eastern Bengal and Assam has since been received.

Burma.

I.—The area under tobacco in Burma amounts to 76,390 acres and is on the increase.

II.—The two principal varieties are "Burmese" and "Havana." No information is given as to the origin of the "Burmese" variety, but the "Havana" variety was introduced into Burma by the Agricultural Department which has for many years annually distributed seed gratis for experimental cultivation.

III.—The cultivation of tobacco in Burma is carried on in land of the best quality. Apparently no manure is applied, nor is irrigation practised, but the dew is depended on for the supply of moisture. Pruning appears to be practised to some extent, but it is not universal.

IV.—See notes by Mycologist and Entomologist.

V.—Most of the tobacco is sun-dried and there appears to be no fermentation done. "In some few cases the leaves are more carefully dealt with and are hung up in bunches in small sheds * * and are allowed to ferment and become cured in the orthodox way * * * *

"The American method of packing in layers and drying gradually has proved itself to be the best, but it requires special experience."

VI.—Figures of the Burma trade have not been supplied.

VII.—The annual distribution of Havana and Virginia seed is the only attempt at improvements that has been mentioned.

United Provinces.

I.—The cultivation appears to be practically stationary; the total area being 51,823 acres.

II.—The varieties grown are of the native type.

III.—In the cultivation of tobacco the best lands are selected and heavy manuring applied and the best methods of tillage resorted to, and repeated waterings have to be given. "In a few places the nitrates in the soil and the water give sufficient of plant food."

IV.—See notes by Mycologist and Entomologist.

V.—The drying and curing do not differ much from the crude methods practised in other parts of India.

VI.—The largest portion of the produce is consumed in the province and besides this there is a large import from Bengal.

VII.—No experiments have recently been tried for the improvement of Indian tobacco. No tobacco is grown for European consumption. Efforts were made in the seventies, but the conclusions drawn were that the climate was unsuitable for the following reasons:—(1) danger from frost and hail; (2) dryness of climate.

Mysore.

I.—The area under cultivation is 17,352 acres, showing a slight increase.

II.—No mention is made of the varieties grown, but they may be assumed to be of the native type.

III.—No mention is made of the methods of cultivation.

IV.—See notes by Mycologist and Entomologist.

V.—The tobacco is cured in the field and is used for native consumption.

IV.—No information as to the trade.

Conclusion.

I.—The total area under cultivation of tobacco in India is 10,600,000 acres.

II.—The varieties, whatever their origin, are mostly of the native type and cannot be classed commercially with the well-known cigar and pipe tobacco of other countries. Only the varieties grown in Coimbatore and probably in Rangpur * (of which no information has been supplied in the notes) are at all fit for European consumption. Foreign varieties have been tried on a small scale, and as far as growth is concerned, some of them have proved quite satisfactory.

* Information received subsequently.

III.—The methods of cultivation are not all uniform, but suit the peculiarities of soil and climate. The habit of topping low tends to the production of a heavy, coarse leaf unsuited to the requirements of the European market.

IV.—For pests and diseases see notes by Entomologist and Mycologist.

V.—The methods of drying and curing are primitive and crude, and unsuited to the production of tobacco for European consumption. No scientific control is anywhere exercised as it is in other countries.

VI.—With the exception of a portion of the Madras and Rangpur crops, the bulk of Indian tobacco is consumed in the country.

VII.—Attempts have been made in the past towards the production of a better class of tobacco for European consumption, but they have failed to bring complete success. The reasons are probably due (1) to the want of the selection of the plant best adapted to a particular locality, (2) to defects in cultivation, (3) to the too strict adoption of the methods of other countries in the drying and curing operations, instead of modifying them to suit the Indian climate, (4) to the total want of scientific control, also suited to Indian conditions.

B. COVENTRY,

Director of Agricultural Research Institute, Pusa.

Note on Insect Pests of Tobacco.

The known pests of tobacco in India are (1) grass-hoppers attacking the newly transplanted seedlings; (2) surface caterpillars destroying the young or half-grown plants; (3) the stem caterpillar, attacking young plants; (4) leaf-eating caterpillars; (5) crickets.

(1) When seedlings are planted out, they are eaten off by the abundant surface grass-hoppers which live on open fallow land. The occurrence of these insects is probably a question of favourable climatic conditions. Clean culture and thorough tillage are the best preventives of attack. The only direct remedy is to dip the seedlings in standard lead arseniate mixture as they are planted, thereby making the leaves poisonous. This is quite feasible and the cost very small, and it has been shown to be effective by two seasons' experiments at Pusa.

(2) Surface caterpillars are those which live on the soil, hiding by day in the earth or below stones, emerging by night to seek out young plants for food. They cut off young or half-grown plants level with the surface and destroy each night more than they can eat. Careful search reveals their burrows or shows the places to which they dragged their food during the night: they can then be found and destroyed. The alternative methods are (i) to poison the young plants, (ii) to put down baits of poisoned chaff.

(3) Stem caterpillar (*Gnorimoschema heliopa*, Low.) is a small caterpillar that burrows into the main stem at or near the axil of a leaf; it lives in the stem and causes a large gall-like swelling. Young plants up to a foot high are principally attacked. The gall need not destroy the plant, but makes it unthrifty and weak. The cultivator's method of cutting open the gall by a longitudinal incision is probably as good as any that will be found, especially if a little care is taken to cut the caterpillar.

(4) The leaves are injured by several caterpillars which occur commonly and generally throughout India. On young plants, spraying the leaves with poison is a sound remedy, that cannot be adopted on leaves nearly ready for curing. In this case hand-picking of the caterpillars must be adopted.

(5) A cricket is reported in Tirhoot to injure the leaves by coming out at night and eating holes in them. This appears to be the common burrowing cricket (*Brachytrypes achatinus*, Stoll.) of this district, which also rarely injures the roots of tobacco by cutting them through. Where such crickets are not abundant they can be readily dug out, the burrows being easily found; this is best done during August and September when the high level

of soil water makes them remain near the surface. In seriously infested localities there is only one thorough treatment, to grow a crop such as lucerne and thoroughly poison it, thereby poisoning off the crickets wholesale.

On the whole, the most widespread and destructive pest is probably the surface caterpillar, whose destruction is simply a matter of care requiring no special appliances or poisons. Only the ryot's aversion to taking life prevents him from treating this pest in a common sense way, and there is no reason why this or any other pest, so far known, should cause serious damage to the crop.

H. MAXWELL LEFROY,
Entomologist to the Government of India.

Note on diseases of Tobacco.

Few diseases of tobacco have been recorded in India. The broom rapes, *Orobanche indica* and *Orobanche nicotianæ*, parasitic flowering plants, are common in practically all the tobacco-growing districts, particularly in Bengal, Madras and Gujarat. The damage caused varies according to the season and the degree of cultivation given. Even where the latter is good, as in Gujarat, and the cultivators constantly remove the parasite, Mr. Mollison states that a bad attack will destroy a quarter of the crop. Ordinarily, however, nothing is done to lessen its severity and it is left to seed freely. Where continuous tobacco cultivation without rotation is practised, the parasite multiplies to an alarming degree. As a rule *Orobanche* affects weak plants to a greater degree than strongly growing ones. Anything tending to increase the strength of the tobacco plant, such as manuring, clean cultivation and rotation, diminishes the attack. The only practicable direct means of lessening its numbers is to prevent seeding by regularly pulling it up when young. Pulling up mature plants and leaving them to rot on the field, as is sometimes done, is useless. Where seed has been shed it is possible that frequently turning over the soil during the period that the tobacco crop is not on the land might serve to destroy a proportion of the seeds. The latter have been shown in an allied species to retain their powers of germination for at least five years.

The tobacco mildew, caused by the conidial stage of *Erysiphe cichoraceaarum D. C.*, is a serious disease in some localities. It is this which is probably referred to in Watt's Dictionary as a kind of grey mildew attacking the leaves in the Azamgarh district of the United Provinces and known as *Kapti.* Last year it caused much damage to shade-grown Sumatra tobacco on the Rangpur Farm, Bengal. Plants growing exposed to sun were not affected. The use of fungicides on the leaves of tobacco is obviously attended with danger, and it has not been ascertained if any treatment is possible. The application of sulphur either in form of "flowers of sulphur" dusted on or as potassium sulphide sprayed on is efficacious in checking many mildews, but might interfere with the curing processes and be difficult to remove from the leaves. Experiment alone can show whether any remedy will prove practicable.

A leaf spot disease, due to *Cercospora Raciborskii*, Sacc. and Syd., is common at Pusa and elsewhere and would injure wrapper leaves considerably. For ordinary purposes its effects do not appear to be very serious.

A few other diseases occur, but are not of much importance so far as can be ascertained. The serious wilt and mosaic diseases of other countries have not been recorded in India.

E. J. BUTLER,
Cryptogamic Botanist to the Government of India.

Note on the Cultivation of Tobacco in the Madras Presidency.

According to the published statistics of the area occupied by different crops, that planted with tobacco has increased as noted on the margin during the last twenty years for which figures are available. These figures, however, only relate to a portion of the Madras Presidency, and the figures for the latest years

1885—89	81,000	acres.
1890—94	99,000	"
1895—99	105,800	"
1900—04	115,100	"

published in the volume of Agricultural Statistics for British India do not agree therewith altogether, as the latter include figures for some areas from which in earlier years no statistics were received, and, thus, if they be looked at, the increase in area under tobacco would appear larger than it really has been. These figures, however, indicate that the area under tobacco in the Presidency is really considerably greater than the figures quoted show, and, possibly, if the area statistics for the large zamindaris of the northern districts were procurable, very much greater; for instance, in the Vizagapatam district it is known that there are at least 10,000 acres more than appear in the tables under tobacco whilst only about 2,000 acres are included above.

The districts which show the largest areas under tobacco are the old Kistna district with an average for recent years of 28,500 acres and Coimbatore with an average of 26,750 acres, to which should be added 6,200 acres grown in Trichinopoly and the parts of Madura adjoining it in the Dindigul country, which is the centre of the Dindigul or Trichinopoly cheroot trade.

Adjoining Kistna on the north is the Godavari district, where in recent years there has been an average of 11,200 acres returned under tobacco and where probably the area cultivated is much greater; and on the west, Kurnool, where the average area has recently been about 12,000 acres. These are the chief localities for tobacco, but the crop is grown in all districts, though on the Nilgiris and the West Coast the area is trifling. Owing to the great fluctuations, consequent on variations in the seasons, it is difficult to trace out the general increase in area referred to above, but in the districts mentioned in particular they have been as follows:—

Period.	Godavari.	Kistna.	Kurnool.	Coimbatore, Madura and Trichinopoly.
1885—1889	10,400	19,800	7,900	18,600
1890—1894	10,500	20,125	10,400	28,700
1895—1899	9,800	26,500	8,700	31,800
1900—1904	11,200	28,500	12,000	33,900

These areas produce tobacco for entirely different markets. The Kistna, Godavari and Vizagapatam districts grow it very largely for Burma; Kurnool exports largely to Hyderabad; and Coimbatore supplies the Dindigul cheroots and the demand for Malabar as well as exporting low-grade tobacco to the Straits. The trade statistics will be dealt with later. The reason for the increasing area is the activity of the several demands alluded to. It is during the last fifteen years that the export trade in South Indian cigars has become firmly established.

In Godavari—The land on which tobacco is grown consists, for the most part, of alluvial islands lying within the banks of the Godavari river and generally liable to be flooded annually, although some portions are so high that they are seldom overflowed. The soil of the *Lankas*, as the islands are usually called, is of course very variable; some parts lying low are covered with deep layers of coarse sand, and in other parts, both high and low, the soil varies from a light friable loam to a stiff loam. The best soil is a fine friable loam composed of the finer parts of the silt brought down by the river. As might be expected, the *Lankas* are being continually altered in contour and size, as well as being overlaid with deposits or washed down to lower levels, The soil, therefore, of *Lankas* high up the river, may be *spread over* those lower down during any season. Tobacco seems to be grown on any part of the *Lankas* almost indifferently, it being grown even on coarse land, provided it is not too deep, and that there is a layer of good soil not more than a foot or so below the surface. What is liked best is a new deposit of fine alluvium 9 inches to a foot deep lying on a sandbank. Amongst such a diversity of soils and in such a changeable land, there are fields which have grown tobacco uninterruptedly for many years and others again have only recently assumed their present form and have grown 0,

1, 2, 3 or more crops. It must also be remembered that the greater part of the tobacco-growing area is annually fertilised by the deposit of silt which the river leaves. I saw the deposit of a recent freshet to be in one place ¾ inch or more thick. Physically, the soils are generally excellent; chemically they have not yet been examined, I believe; but if my memory serves me right, Mr. Broughton's analysis of the ash of *Lanka* tobacco showed it to be richer in the scarce constituent of potash than most other South Indian tobaccos; this would tend to show that the soils are chemically well suited for the crops.

The tobacco seed is sown about September or October in seed-beds, which are very carefully prepared and cleaned, and generally situated near the villages where the ryots reside. The preparation is now beginning and will go on till the time for sowing the seed arrives. These seed-beds are heavily manured by folding cattle and sheep on the land and also with village sweepings, and the land is frequently stirred with the native plough until a good depth of loose mould is formed. The amount of seed allowed is about 1lb. for 8 acres, or 2 ounces per acre, and at the time of sowing it is mixed with fine sand in the proportion of 1: 16 and sown broadcast over the area of the seed-beds; the beds are thereafter watered lightly three or four times a day for some time. The plants come up in about a week. After this they have to be watered carefully and weeded till the time comes for planting out, which is from the beginning of November till early in January. The plants, if strong and well grown, may be planted out when one month old, but oftener, I believe, they are not transplanted till two months old, as they are said to be 9 inches high and to have six or seven leaves as much as 3 inches in breadth at the time. Before planting, if it be long, the tap-root is cut to prevent its being twisted when inserted in the hole made for the reception of the plant. The side roots are also trimmed.

The preparation of tobacco fields begins after the last freshets have passed down the river. When I was on the *Lankas* they were for the most part either covered with a layer of new silt or a mass of weeds and grass; the latter being allowed to grow freely as it affords a lot of grazing for the cattle from the delta lands where pasturage is so scarce. After the rains are over, the grass, etc., dries up and is got rid of in a temporary manner by ploughing before the planting season begins. After the weeds have been ploughed up, small holes are made in the soil, the depth varying with its nature; for, in cases where the good soil is overlaid with sand, an effort is made to reach the former, and also in some cases a little good soil is brought and poured into the hole around the plant when the sand is very deep. The plants are put in from two to three feet apart and are watered by hand from pots daily for a month or more. About three weeks after planting, the land will usually be weeded; *one weeding only being general.* The weeding is usually done with a small spud (*tollika*), but sometimes, *if the grass is strong*, and sometimes also if rain falls and "sets" ne surface, it is hoed with a *mommatti.*

We have then the plant grown on soils under most varied physical conditions and on some which have been cropped for many years and in others only recently first planted. The land is left to grow up into a jungle of grass and weeds for half the year or more and is then hastily prepared and planted with a delicate plant, and very little after-cultivation is given to it. If there is one thing which the tobacco plant requires and benefits from, it is having the land it is growing on kept in a free, open and clean state during its growth. My visit has been at such a time of year as to prevent my satisfying myself as to how far this is done, but I believe from what I heard and saw that it is hardly ever thoroughly accomplished.—(C. Benson's report, dated the 18th July 1883; *vide Bulletin No. 2 of this Department.*)

"Two months after planting, when the plants are 2½—3 feet high, they are topped leaving about 12 leaves, and again a week later. Three months after planting the crop is ready for harvest. A month after the first crop is cut buds which appear in the axils of cut leaves are ready for cutting." (*Venkatakrishnama Naidu, First Assistant Government Botanist.*)

"The leaves of the plant are in every case cut off with about one inch of stalk attached (as required by the Cocanada merchant); these leaves are allowed to wilt in the sun for one day, then strung up under a thatched roof running close to the ground, the two sides north and south remaining open. The

colour obtained is much varied,—light red, yellow and green predominating; all these colours turn more or less black (but seldom uniform in colour) after heating; this is done by sprinkling the cured leaves with water and then heaping up to induce fermentation; the results necessarily leave much to be desired some of the leaves getting heated more than the others."

"The method of curing adopted is the same in all the *Lankas*; the mistake lies in keeping the tobacco whilst in its green stage too much exposed to sun and light; hence too rapid evaporation and consequent drying of the sap, resulting in the colours being mottled green, yellow and light red."

"The quality of the present *Lanka* cigars is execrable, being strong, rank, hot, and saltish to the taste, besides being gritty and full of sand. The amount of gritty sand that abounds in the *Lanka* tobaccos is due to the slovenly and careless custom prevalent amongst the ryots in allowing the green tobacco, after it is cut, to remain two to three days heaped upon the ground; every day these heaps are opened and the tobacco spread apart."

"The tobacco on these *Lankas* throughout is deficient in gum and elasticity, the texture rough and slightly papery, ribs and veins straight and fine. The deficiency of gum and poor texture may be attributed to the unfavourable season."—(*Extracts from Reports by H.Caine, dated 1889.*)

In Kistna—The crop is chiefly grown in the upland taluks in ordinary black cotton soil. This soil is capable of absorbing large amounts of moisture from the air, much of which is brought to it by the easterly winds, "*paira gali*," which blow over this part of the country during the tobacco season from December to February. This is the season of heavy dews, and in the mornings the country is covered with a heavy mist which clears away during the day.

Sites for the seed-beds are usually chosen near shallow pools in which the monsoon rains stand. These sites are well ploughed and manured. After the first ploughing, cattle are picketted closely on these plots, and then they are ploughed once or twice more. After this village manure, which consists largely of earth and ashes, together with dried cattle-dung, is applied at the rate of 50 to 60 loads per acre. Thereafter two or three more ploughings are performed whilst the land is moist, but not wet, and the seed is sown broadcast mixed with sand or ashes and then pressed in with the hand. Seed is sown at the rate of about one local seer for 18 cents of land. The beds are sometimes covered with the stalks of red gram (*Cajanus indicus*). At first watering is frequent and even as often as 3 or 4 times a day. The seed germinates in 7 to 8 days, and when the plants are 20 days old watering is reduced to once a day, the plants being then about 4 inches and having 2 to 4 leaves. The ryot goes over the beds daily and picks off leaves that are unhealthy. About two-and-a-half months after sowing, when the plants are 8 to 9 inches high to the end of the shoot and 12 inches to the end of the uppermost erect leaf, the plants are cut back without injuring the apical shoot, and 15 days later they are pulled up and bundled for planting. The preparation of the land intended for the crop commences about July as soon as rain allows of ploughing being begun. Before this such village manure as is available, and tank silt where procurable, are applied; and folding cattle, sheep and goats is done after the first ploughing. The land is worked from 7 to 10 times with the plough and then twice with the *gorru*, and afterwards marked off for planting in squares with the scuffle. Holes are dug at the corners of the squares and filled with water and the plants are dropped in and then the earth is gathered round them. The plants are watered for two days in the mornings and then for two more days in the evenings, but thereafter they have to depend on soil and air for moisture. If the land is dry, a small three-rowed *gorru* is worked between the rows, and once in fifteen days a small bullock hoe is so worked up to the time for harvest.

The crop is topped when 2½ feet high and suckered 20 days later; and about 10 days after the latter operation, when there are 15 to 24 leaves on the plant and it is about 3 feet high, the crop will be ready for harvest. The leaf is considered fit for harvest when the dark green changes to a light brown, and this change should appear in all the leaves which are all cut at the same time. The harvest takes place in February and March. No second growth occurs, and the stems are cut later and used for fuel.

As soon as the leaves have been cut they are strung up—about 200 on a string—by their petioles, and the strings are stretched across a framework of bamboo, 6 feet square, which is set up in the open. Here the leaves dry during the day and absorb moisture during the night from the dew, and this renders them pliable. In 17 to 18 days the leaf becomes thoroughly dry, and on the 20th morning they are taken down and removed to the house and there piled in heaps. The heaps are turned only once and the leaf is then regarded as ready for sale. If a purchaser comes the heap is sprinkled with water and on the following day the bulk is opened, and if any of the leaves stick together they are carefully separated and again sprinkled with water. When the leaves no longer stick together they are pushed up close together on the strings so as to occupy about 6 to 8 inches, and generally the 200 leaves will then weigh when cured about 3lbs. The blocks are placed side by side, but the position is changed several times during the next 10 days. They are then placed upon broken bits of tobacco leaf spread, or palmyra leaf laid upon gunny bags. Nothing but pure water is used in the preparation of the leaf.—(*C. A. Barber, Notes of 1902.*)

In Kurnool—The crop is raised under very similar circumstances as to soil and atmospheric conditions to those described for Kistna. The soils chosen are usually the black cotton and mixed loamy soils, and the crop is grown during the season of the easterly, dew-bearing winds, "*paira-gali,*" and it is grown for the most part as an unirrigated crop.

"The seed is sown in flat beds about July, and the seedlings are large enough to transplant in five or six weeks, when plants with leaves 3 or 4 inches long are selected and they are usually put out in the evening. They are placed about 2½ feet apart in both directions. During its growth the crop does not receive much attention, and is usually topped when about two feet high. The crop is thought to be ripe when brown spots appear on the leaf and when the leaf will crack if doubled up between the finger and the thumb. The most favourable weather for harvesting is that when heavy dews fall at night and the sun is hot during the day. When it is ripe, the plant is cut close to the ground, and then a number of the plants are gathered into rows and then left exposed for about three days.

"After this, the plants are piled, two plants high, one on top of another, and remain like this for five days. They are then taken under shelter; the stalks being still green, but the midribs dry. Under shelter, bulks are made up according to the amount of leaf available, but the usual size is about 10 feet and 5 feet wide. These heaps are covered round the sides and on top with straw and palmyra leaves and are weighted down as much as possible. After 4 days the bulk is opened, the plants shaken out and cooled and then again heaped up; and so on as often as the heap grows hot. This continues for about 15 days.

"The leaf is supposed to be properly fermented when it turns red, that colour being most desired. After 15 days the leaves are stripped and tied into bundles of about 10 each. These bundles are then again placed in the heap for about a month, the heap being opened and turned when hot. The leaf is coarse, the ribs thick, the colour uneven, and there is little gum. The plant is topped low in order to secure a large, heavy leaf, which suits the native market."—(*H. Caine in a Report of 1887.*)

A revised and annotated description of the method of growing tobacco around *Dindigul* has recently been published in Bulletin No. 53 of this Department, so that it does not need repetition here. It may, however, be noted that the reputation of the produce of different "gardens" around Dindigul varies greatly, and the main differences in this respect are attributed by the people to the well waters. Formerly, in this neighbourhood, the *Usi-kappal* variety was largely grown, but it has now been displaced by the heavier and coarser *Wara-kappal* variety in those gardens which produce cheroot leaf.

"*Usi-kappal.*—This variety is *par excellence* the most suitable for cigar manufacture, and is also largely cultivated by the tobacco ryots for this purpose; it, however, requires more careful treatment than the ryots are disposed to give it. The seedlings, when growing, are delicate, and require much care in transplanting; the plants should be at least 3 feet apart from each other

when planted out in the field, as, from its name 'needle-shaped,' the leaves are apt to run to too fine a point with the ribs too lateral if planted out any closer; the plant while growing requires great care and frequent hoeing; the grass-hoppers and caterpillars are extremely fond of the fine delicate leaves of this plant, whilst the coarser varieties, like the *Wara-kappal*, are not so much appreciated. The *Usi-kappal* plant has in fact everything required of it as a cigar wrapper, the leaf being fine and of a good texture.

"*Wara-kappal.*—This indigenous plant, the broad-leaf variety, requires the least care of all whilst growing; the plants grow very fast, somewhat to the detriment of plants of other and more delicate varieties growing in the vicinity; the rate at which this variety grew was quite double that of the other plants. On ripening, the leaves thickened considerably, and the texture became coarse with thick ribs."—(*H. Caine in 1890.*)

"*Varieties.*—Except as noted incidentally above, there is but little on record on this point. The Godavari tobacco is believed to be of an entirely distinct variety from that grown at Dindigul; and besides the two sorts already mentioned as being grown thereabouts, there are others regarding which the following information has been received at the last moment from a subordinate of much experience in tobacco cultivation in the central and southern districts, who is at present on leave:—

Varieties cultivated.—(1) *Valai-kappal*, (2) *Usi-kappal*, (3) *Suri-kappal*, (4) *Monnai-kappal*, (5) *Vattai-kappal*, and (6,) *Erunnai-kappal.* Nos. 1 and 2 chiefly grown for cigars; No. 3 for making snuff, and the rest for chewing.

Characters.—The cultivation of *Usi-kappal* is very limited. It has the thinnest and finest leaf, with fine midribs; the leaves are very narrow, tapering to a point; bulk for bulk it is the lightest variety. *Suri-kappal*, thinner and narrower than *Vattai-kappal*. *Vattai-kappal* is the chief variety grown for cigars; in point of fineness and texture, etc., it occupies a middle place between *Usi-kappal* and *Suri-kappal* on one hand and *Erunnai-kappal, Vattai-kappal and Monnai-kappal* on the other. This variety is also used for chewing. *Erunnai-kappal* is the coarsest, thickest and broadest leaf; it is the principal variety grown for chewing purposes. The midribs are very thick. *Monnai* and *Vattai-kappal* are akin to one another. The leaves do not taper much but have a somewhat rounded appearance at the tip. These are also grown chiefly for chewing. As tobacco is used for different purposes, the method of cultivation and curing adopted differs.

(1) *For cigar making.*—With very slight modifications the method of cultivation and curing practised by the Dindigul ryots as described in the revised Bulletin applies.

(2) *Snuff tobacco.*—This class of tobacco is never irrigated from wells, being grown by the aid of rain alone. The land is well tilled and manured with village ashes, and sometimes with the droppings of cattle and sheep. Seedlings about two months old are dibbled from September to November, 18 inches apart. A small quantity of water is poured over each seedling after dibbling by coolies, who follow the planting with pots of water. This kind of pot watering is repeated twice or thrice according to the nature of soil and the weather, at intervals of 4 or 5 days until the seedlings strike root. If the weather be rainy no watering is given. Topping and suckering are done as usual, but when the crop is harvested it is cured as follows:—

The crop is cut in the evening and allowed to lie till 9 on the following morning. It is then gathered and arranged in heaps, and in the evening, after 4 P.M. the heap is opened and the leaves are spread on the ground to absorb as much dew as possible, being allowed to remain till 9-30 or 10 A.M. next morning and are then heaped, the heap being again opened at 3 P.M. In this way the leaves are gradually exposed for longer hours to the sun for about a fortnight. In some cases, after 10 days' exposure in the manner described, the plants are tied up and hung to dry. When the leaves are sufficiently dry they are gathered on a dewy morning and stacked. The stacks are opened and rebulked once in three days for about a fortnight. Leaves are then stripped, bundled and then piled into heaps. These heaps are opened once in three or four days and again rebulked. In this way 10 or 12 turnings are given. The leaf is then ready for the market. The chief centres for snuff tobacco are Trichangode, Rasipuram and Uttankarai taluks in Salem district.

Chewing tobacco.—The method of cultivation is the same as for cigar tobacco; but while in the case of cigar tobacco, watering the crop is insisted on a day or two prior to harvest, for chewing tobacco watering is withheld for four or five days before harvest.

Curing.—Tobacco is cut in the evening and the plants exposed to the dew till next morning. At about 9 or 10 A.M. they are gathered and bulked into a big heap and allowed to remain therein for two days. During this time much heat is generated within the heap, which decreases in size and much sweating is very often noticeable in it. On the 3rd day the bulk is opened, the plants are taken out and spread to dry in the sun for a day or two or even more. Then the leaves are stripped off the stems, tied into bundles and dried in the sun. Each evening the leaves are gathered and bulked and on the following morning they are exposed to the sun. This is repeated until the leaves are sufficiently dry. Rebundling is now made and the stacking commences. Once in 3 or 4 days the bulk is opened and rebulked. In about two months' time curing is finished and the crop is fit for the market. The above method is followed in Tinnevelly district and is called *uruttu-padam*. In this no special care is taken in the manipulation of the leaf. In another method called *tagatti-padam* much care is taken, each leaf being evenly spread and folded into two from the time of stripping until curing is finished. Leaves thus folded and cured always fetch a better price than others. In Coimbatore, however, the leaves are not spread on the floor to dry as in Tinnevelly. They are suspended on poles for about 3 weeks, then removed and stacked for a few days; the bulk being opened at intervals of 3 days or so. The leaves are then stripped, bundled and stacked for about 40 days, the bulk being opened and rebulked once in 3 or 4 days.

Another system of curing practised by ryots in Coimbatore is to place the green leaves after harvest in large circular pits to a depth of about 5 feet or more. The sides and the bottom of the pit are lined with *varagu* straw. After stacking, the leaves are covered with *varagu* straw and weighted with earth. The pits remain covered for about a week or even 10 days; they are then opened and the leaves taken out, when they appear to be completely rotten. At this stage they are hung to dry on poles erected for the purpose. The remaining process of curing is the same as has been described above. Leaves cured on this system and the leaves cured in Tinnevelly district are dipped in palmyra jaggery water and used for chewing. Chewing tobacco cultivated in Dindigul, Salem and Chidambaram, etc., does not appear to be treated with jaggery.—(*R. Ramswami Iyer.*)

Diseases.—Except as regards the parasite *Orobanche nicotianæ*, regarding which a series of papers was published in Bulletin No. 2 of this Department, the diseases of tobacco have not been studied. That parasite is common in all tobacco fields except in Kistna (*C. A. Barber*) and especially so in Godavari, Kurnool and some "gardens" in the Dindigul country.

In the nurseries in Kistna, Mr. Barber remarks that "two diseases are known to the ryots: (i) *hetukiregilu*; the leaf becomes dotted white. This generally occurs at the fourleafed stage and the plant quickly dries and falls down. This is called the palmyra leaf disease. (ii) *Budoluregul*. This occurs especially if the plant is allowed too long in the seed-bed. The crown becomes rounded and a white grub is fund inside. This disease also occurs in the crop in the fields." Mr. Barber also observes that "the chief diseases met with in tobacco cultivation in the northern parts of the Presidency appear to be insect pests—caterpillars, grass-hoppers, etc., and a phanerogamic root parasite called 'Bodu.' The former have not been studied and are not severe; the latter is *Orobanche nicotianæ*."

Mildew on the leaf is common both in the nurseries and the tobacco fields in some seasons. Caterpillars do a good deal of damage in some cases by eating the leaf, but the worst disease, no doubt, is "bodu" or "malle."

Tobacco Trade.—This may be divided into three sections:—

(i) that which is carried on by rail within the Presidency and with other parts of India;
(ii) that carried by coasting craft with other parts of India;
(iii) the foreign export trade.

Of these, the first two are by far the most important, judged by the volume of the trade, but the traffic by rail has greatly expanded during the last twenty years. Dividing that period into four, each of five years and in each case taking the years immediately succeeding those for which area statistics have already been given, the following results are obtained :—

Average traffic by rail in thousands of maunds :—

Description.	During the five years ending.			
	1904-05.	1899-1900.	1894-95.	1889-90.
Between different parts of the Presidency.				
Cigars	11·0	9·0	10·3	...
Unmanufactured tobacco	419·8	278 0	171·4	...
Other sorts	13·5	12·5	30·5	...
Total	444·3	299·5	212 2	181·8
Exports to other parts of India.				
Cigars	7·25	8·35	9·35	...
Unmanufactured tobacco	98·8	108·9	82 7	...
Other sorts	27·3	1·4	2·0	...
Total	133·35	118·65	94·05	57·4

It is not possible to make the comparison complete in all details for the whole period as a change was made some years back in the classification followed in the trade statistics. These figures, however, show that the movements of cigars have been fairly constant, and considering that these are very largely used by the European population, this is not surprising and the slight decline may be put down to the growing habit of using pipes and cigarettes. So far as unmanufactured tobacco and "other sorts" (for these must be taken together owing to there being reason to doubt the accuracy of the classification in some cases), the expansion of the internal traffic is very striking. It has chiefly occurred during quite recent years. It appears largely against the great Delta districts in the north, the central districts (Salem, Coimbatore and Trichinopoly), and Malabar. The latter is mere transhipment of tobacco brought in, partly at least by road, chiefly to Calicut and also during the latest years to the Native State of Cochin. The average figures for each of the last two quinquennia for the groups of districts chiefly concerned are noted in the margin in thousands of maunds. The increase is, no doubt, partly due to the extension of railway communication, which has especially affected the deltas, the North Carnatic and Malabar. In the exports of the unmanufactured leaf to other provinces the total increase is not large, nor on the whole has there been much change in direction. Mysore has taken an increasing quantity, exceeding 50,000 maunds in recent years; the demand for Hyderabad has been steady, and whilst Bombay has taken less of late years, the Central Provinces and Berar have taken rather more.

Tract.	During the five years ending	
	1904-05.	1898-99.
Central districts	177·8	120·2
Deltas	74·1	40 4
Deccan	45·5	47·3
North Carnatic	30·4	*9·0
Malabar (figures incomplete.)	40·7	28·0

* Figures incomplete.

In dealing with the second and third sections of the trade mentioned above, it seems advisable for the purpose of this paper to club the results together. These are shown in the following abstract :—

Sea-borne trade in tobacco—in thousands of pounds—Exports.

Description.	Whither.	Average during the five years ending			
		1904-05.	1899-1900.	1894-95.	1889-90.
Cigars	Foreign	693	460	330	166
	Coastline	363	279	400	412
	Total	1,016	739	730	578
Unmanufactured tobacco	Foreign	1,123	1,037	1,012	1,360
	Coastline	8,646	9,115	7,186	6,529
	Total	9,769	10,452	8,198	7,889
Others	Foreign	6	10	13	20
	Coastline	22	21	17	47
	Total	28	31	30	67
	GRAND TOTAL	10,813	10,222	8,958	8,534

Prior to 1885 the exports of cigars amounted to about 90,000 lbs. per annum only, of which only about thirty or forty thousand went to Europe. From that time forward up to about 1900, there was a steady increase in these exports. The war in South Africa then led to a great demand in those parts, whilst the demand in Europe increased to some extent and specially outside the United Kingdom. The most marked increase in the demand for cigars, however, has been in the Straits Settlements, which in the first quinquennium of the period took only 13,000 lbs. from the Presidency and in the last as much as 244,000 lbs., the exports of the last five years having been nearly double those of the five years preceding. In the case of the exports of cheroots coastwise, the fluctuations are mainly due to variations in the demand in Burma. At the beginning of the period, that province took 153,000 lbs. of cheroots from Madras, but subsequently this demand fell off to an average of only 60,000 lbs., during the five years ending in 1899-1900. During the last five years dealt with, the exports have, however, again averaged 152,000 lbs. per annum, and the increase has been a growing one. It will, therefore, be seen that, so far as this over-sea demand is concerned, it is that which has sprung up in the Straits that is the most important, when considering the volume of the trade. It is to Europe and South Africa, however, that the bulk of the more expensive cigars have recently been sent, and so far as South Africa is concerned, the demand has, since the war, fallen off to very small dimensions, and it is believed that the market there was greatly over-stocked during that time. The demand in Europe does not show any very marked expansion on the whole, though the increase from 105,000 lbs., taken during the first to 281,000 lbs. during the last five years of the period is a satisfactory one, and there is no doubt that, if the merchants and dealers engaged in the trade devoted more skill, energy and capital to it, a very marked and profitable development would ensue.

The bulk of the sea-borne exports of tobacco from the Presidency is, however, in the form of unmanufactured leaf, and the course of the trade in this may best be exhibited as follows :—

Average exports of unmanufactured tobacco—thousands of pounds.

Whither.	During the five years ending			
	1904-05.	1899-1900.	1894-95.	1889-90.
Burma	7,395	8,532	6,567	5,987
Other Provinces	1,251	883	618	532
The Straits	1,003	902	810	1,161
Ceylon	92	74	81	35
Mauritius and Reunion	17	42	105	158
Other countries	11	19	16	6
Total	9,769	10,452	8,197	7,879

The figures speak for themselves, and show that Burma and the Straits are the chief markets for Madras tobacco, and that the demand for it has been a growing one. The large exports shown, especially of recent years, to "Other Provinces" of the Empire consist chiefly of tobacco sent by sea to the Native State of Travancore, though a good deal also goes to Bombay. Travancore might almost be regarded as a part of the Presidency, but it is treated separately in the Trade Statistics. If now the total exports of tobacco from the Presidency, whether by rail or by sea, be looked at, it will be seen that these have increased from about 13½ million pounds on the average for the first five years of the period to over 22⅔ million pounds during the last five, and the greater part of this has been unmanufactured tobacco for the native markets of Burma and the Straits, though to the latter part of the world a greatly increased quantity of cheroots has been exported of late years. These statistics do not take any cognisance of exports by road, which are believed to be considerable, especially to Hyderabad and Travancore.

Measures for improvement.—It cannot be said that any measures for the improvement of this crop have been taken within official memory. There have at times been efforts made, in a rather haphazard way, to introduce new varieties from abroad, but almost, if not entirely, without success, for these attempts have proceeded on an altogether wrong basis, as it has not first been ascertained by experiment whether any good could possibly accrue if they were successful, and also whether there was any chance of successful introductions being made. About 15 years ago, the Madras Government engaged the services of a professional tobacco curer from Pusa, and he was, after making an extended tour of enquiry in the Presidency, stationed at Dindigul and there he arranged with some ryots to grow tobacco under his instructions, and later on grew some himself on leased land. The main object of his work, however, was to endeavour to improve the process of curing, and this he tried under shade, putting up temporary leaf sheds for the purpose. The result was not a success, but it showed two things clearly : one was that if results are desired, a considerable amount of time must be taken in acquiring local knowledge both with reference to the growing of the plant and with reference to the arrangements necessary for securing the proper conditions for curing. The second point was that it is never profitable or advantageous to break off an experiment until some decisive result is obtained. None such was obtained in this case.

Save in the way of some attempts to improve by careful curing the quality of leaf turned out in inferior "gardens" which have been made during the last season by a firm for the Department, and by affording another firm facilities for obtaining suitable land at favourable rates on condition that it carries on similar operations, there are no experiments with tobacco at present proceeding.

Neither of these is at present in such a state as to demand further notice here.

What is needed.—As to the future, the first thing necessary is to make a careful and scientific study of the conditions that go towards producing the great differences in the quality of the produce of different gardens; and for this the assistance of an Agricultural Chemist on the spot is needed. The second is careful study, on a farm where the conditions under which they are grown can be controlled, of the different indigenous varieties of tobacco and the carrying on of a series of carefully-designed manuring experiments with a view to determining, in conjunction with the study first mentioned, how the necessary soil conditions for producing the higher classes of leaf may be arrived at. Besides this, the working out of the best feasible manner of drying and afterwards of curing the leaf under local conditions needs attention.

The objects to which attention should be directed are:—First, to produce a leaf, which, in appearance and quality, will serve as a wrapper for cigars to be put on the European market. Secondly, to increase the yield of the lower grade leaf per acre; the latter being altogether secondary and pre-supposing a failure, more or less complete, in the former direction.

What the Department needs is the aid of a chemist to make the required scientific investigations; and a curer of such capacity and breadth of view as should be able to adapt himself to local conditions rapidly. The central farm now being established near Coimbatore should be a suitable place for the experimental work indicated.

Tobacco grown for European consumption.—The answers to the questions put on this point are, as far as it is possible to give any, as follows, presuming that much may be repetition of what has already been said:—

The tobacco grown for this purpose is chiefly that raised around Dindigul, the variety now raised being, for the most part, the broad-leafed *Wara-kapai*. No information is available as to origin of this variety, nor as to when it was introduced; nor again as to the area occupied by it. It is grown as an irrigated crop, and, in fact, a full description of the manner in which it is grown, etc., is given in Bulletin No. 53 of this Department. The price varies greatly from R30 or R40 to R140 a *pothi*. The chief market for the unmanufactured article is Dindigul and, to a more limited extent, Trichinopoly and some places in the Coimbatore district. As to consumption, all the information available is given in the Review of the Trade Statistics. The leaf is used for cheroots, and chiefly, and especially of late years, for fillers, though some of the best is used as wrappers for pure Indian cheroots. To give quantities is impossible. The method of curing is described in the paper quoted, and it is entirely uncontrolled from a scientific point of view.

Experiments were made about 15 years ago on behalf of Government in shade-drying and careful fermentation, but the results were not satisfactory. The main reason for failure was that the experiments were not continued long enough, and, secondarily, that a sufficiently careful selection of land was not made on which to grow the plant to be experimented with. During the season now past, further experiments in drying and curing, under control, have been made for the Department by a firm of cigar manufacturers, but with inadequate arrangements for the regulation of the degree of moisture during drying, etc. So far as these have gone, the promise of being able to turn out a satisfactory wrapper, from what has hitherto been a second grade leaf, is great.

Besides the Dindigul centre, some cheroots are made up from Godavari tobacco, either as "Lankas" or "Burma" cheroots for European consumption and a firm has, in the last year or two, been making experiments in scientific curing of the *Lanka* leaf, but no exact information is at present available as to the results.

C. BENSON,
Deputy Director of Agriculture, Madras.

BENGAL.

1. *Extent of cultivation, etc.*—No definite information is available as to fluctuations of area. In some tracts, as for instance Purneah, the area under

tobacco has apparently fallen off to some extent owing to bad prices and the competition of jute.

2. *Varieties, etc.*—Two varieties, *viz.*, *Nicotiana tabacum* and *Nicotiana rustica*. The former is generally called *deshi* and the latter *villayati*. For a botanical description of the two varieties see "Field and Garden Crops of the North Western Provinces and Oudh" by Duthie and Fuller, Part I, page 69. *Villayati* is largely cultivated in Purneah and its neighbourhood, where it has completely supplanted the *deshi* variety. No races of this variety are known. The *deshi* variety has many races. Of these the most important is known as *Hingli* grown in parts of Nadia and Jessore. Several races are recognised in Tirhoot as *Khagra, Churiya, Narayen, Dhamakal, etc.* The last two have very large and broad leaves. *Dhamakal* is also called *Jati* in some parts. Tirhoot tobacco is known in the Calcutta market as *Motihar*. No information is available as to the origin of the varieties or races, or as to their time of introduction into the Province.

3. *Methods of cultivation, etc.*—There is little difference in the different tracts. The *Hingli* variety which is cultivated in the Ranaghat Sub-Division of the Nadia District and the Bongong Sub-Division of the Jessore District is cultivated as follows :—"Seed is sown in the nurseries in the latter half of August (4th or 5th to 10th *Bhadra*). The nurseries are manured with *bheel* silt consisting of decomposing water plants and with well rotted cowdung in April and May. The tobacco fields are also manured the same way and at the same time. The nurseries and the fields are repeatedly ploughed, and the clods crushed with a *mai*, or ladder, four times every month if possible. After sowing the seed, it is pressed with a *mai*. No watering is given before germination, and only very seldom after germination, if necessary."

The seedlings are transplanted out in the first-half of October (from about 20th Aswin to 2nd or 3rd Kartic) when they are 3″ or 4″ high. They are planted in rows 18″ apart and about the same distance apart in the rows. After transplantation they are immediately irrigated the same day. Generally two more irrigations are given, once when the plants are about 6″ high and again in the first-half of December, some 10 or 12 days before harvesting. The fields are hoed twice or thrice after irrigation and rain, at first with a *khurpi*, or hand hoe, and later on with a spade. The plants are topped when they get 12 or 13 leaves. Then suckering goes on regularly every eight days till harvesting. The plants are cut down when the leaves hang down, turn colour and have spots upon them. No priming is known or practised. No rotation is practised. Tobacco after tobacco is said to give the best result. But the *hulla* parasite (orabanche) has become very troublesome lately and the raiyats are obliged to change their fields every few years (see paragraph 4).

In Tirhoot the seed is shown in the seed-bed from the end of July to the middle of August (*Sravan*). The seed-bed, as indeed the tobacco field itself, is at the homestead where the cattle and buffaloes are kept. The seed-bed is carefully prepared with handspading ; and after sowing the seeds are lightly brushed over with a broom and then firmly pressed with the hand to prevent them getting washed off by rain. The seedlings are ready in about two months when they are planted out (October). Immediately after transplanation, which takes place in the afternoon, a watering is given. On the following day another watering is given and the little plants protected from the sun with castor leaves, etc. On the third day the coverings are removed. No irrigation is found necessary unless the weather is very dry. The plants are topped when about a foot high and suckering goes on at intervals of a fortnight or so. Generally four suckerings are found necessary. The fields are hoed with *khurpis*, or hand hoes, every fortnight or so. Cattle-manure is the mainstay of the tobacco cultivators. The cowdung obtained during the rains cannot fortunately be made into fuel cakes for want of dry heat, and is used for manuring the tobacco land. Indeed, as already mentioned, the animals are kept upon the field from *Cheit* to *Bhadro*, being taken indoors, when it rains. Ashes are also used. Indigo refuse is very highly valued as manure, the raiyats often paying ₹70—80 or even ₹100 for a bigha (very nearly an acre) of factory land manured with seet as this refuse is called. In Tirhoot tobacco is grown on the same land only in alternate years.

The following rotation is followed :—

1st year.	Rainy season	Fallow ploughing.
	Rabi season	Tobacco.
2nd year	Rainy season	Maize.
	Rabi season	Wheat or barley mixed with peas, etc.

Harvesting begins in January and goes on till *Cheit*. Generally a ratoon crop is taken from the same plants. This is very inferior to the main crop both in quality and quantity. The main crop is known as *morhan* and the ratoon as *doji*. If the main crop is cut in *Fagoon* (February—March) the second cutting takes place in *Bysakh* or *Jeth* (May).

The crop is generally sold by the raiyats to local *mahajans* while standing in the fields. The average price obtained is ₹5 per cottah for the main crop and only annas 8 to 12 per cottah for the ratoon. But a crop grown on seeted land may fetch double this price. When cured and ready the *morhan* sells for ₹8 to 10 per maund while the *doji* for no more than ₹2 per maund.

Cultivation of villayati tobacco in Purneah.—There is no rotation but tobacco is grown on the same land year after year. Indeed the longer the field is under tobacco the better are the outturn and quality supposed to be. The only manure known is cowdung. Cattle are kept upon the land which is close to the homestead, as in Tirhoot, all through the summer and rainy season, and ploughing proceeds also as in Tirhoot.

The seed is sown in the nursery in *Aswin* (early in October) and the seedlings are ready for transplantation in about a month. They are set out in rows 12″ apart and about the same distance apart in the rows. This is much closer than the practice followed with the *deshi* and *hingli* varieties. When the plants are 5″ or 6″ high they are topped leaving only about half a dozen leaves to each plant. The suckerings are made 3 or 4 times. The plants are harvested entire, as in other places, when the leaves become crisp and spotted. If the transplantation takes place in November, the plants are cut in February. If in December they are cut in March or early in April. No ratoon crop is obtained with this variety.

4. *Fungus diseases, insect pests, etc.*—In Nadia the parasite *hulla* or *hoolloo* has become a serious pest. It was known from before, but has become very common for the last 5 or 6 years. No remedy is known. It is most serious especially on good land. If the field is not used for tobacco for 2 or 3 years, the *hulla* may not attack the crop very badly the first year it is resumed, but becomes as bad as ever from the second year again.

Several insect pests are known of which the most important is the *kélé poka* (Nadia) or *kari* (Tirhoot). It is simply called the *pillu* in Purneah. It is, as its name implies, a black looking grub about 2″ long which hides itself during the day in the ground and comes out at night especially in cloudy weather and cuts the stems. The raiyats' remedy is to dig it out and kill it. Whenever a plant suddenly begins to wither, the raiyat looks for the insect at the root of the plant. No other insect is known in Nadia or Purneah.

Two other insects are known in Tirhoot, one of which is the *gheg* (literally goiture) so called from its producing a swelling in the stem inside which it lives. This insect is troublesome only when the plants are still young. The raiyats' way of dealing with it is to cut the plant away below the swelling and crush the stem with the insect inside. The stump left in the ground sends up fresh shoots.

The other insect known in Tirhoot goes by the name of *jhansi*. It lives on the leaves and eats holes into them. It is shaken off the leaves and killed.

No fungus diseases were mentioned to me.

5. *The methods of manufacture, curing, etc.*—The *hingli* variety is more carefully dealt with than the others, and its method of curing may be described in detail. The plants are harvested from 25th *Pous* to 15th *Magh* (10th to the end of January), and carted off at once to a grassy plot to prevent the dust of the fields sticking to the leaves. The plants are cut up into three pieces, each piece having from two to five leaves. The pieces are now spread out in

the sun for three days at the end of which they are gathered together and hung up in the shade (inside cow-sheds and houses) on grass ropes. They are let alone for a couple of months till the south wind, bringing fogs with it in the morning, sets in and the leaves are in "case" as it is called. The leaves are now taken down with the ropes. The ropes are cut into pieces of about 18" or 20" with the leaves hanging from them and tied into loops.

The sweating or fermentation now begins. A number of bamboos are spread on the floor of the house and some straw placed upon them to avoid the damp. Over the straw the tobacco is piled up in heaps of 50 or 60 maunds. Gunny sheets are used in covering the heap. The temperature rises as the fermentation proceeds, and the degree of heat is felt by the hand. When the proper temperature is reached the heap is broken up and re-arranged to prevent overheating; the top and bottom leaves go to the centre and the inside leaves come to the outside so that the fermentation may take place evenly. The interval between building the first heap and breaking it up varies, depending upon the *case* or moisture in the leaves. A third hedping may be necessary if the leaves are still soft.

In Tirhoot and Purneah the leaves are cured entirely in the sun, the plants are cut and left in the fields for 4 days or so. They are then carried to a grassy plot where they are daily spread out in the sun and gathered into small heaps at night till the dry west wind sets in when it suffices to repeat the operation every 2 or 3 days (Tirhoot). After a month or so the plants are taken home, the leaves are separated from the stems, tied into "hands" of 6 or 7 each and the fermentation begins. The piles are built up of 10 to 15 maunds; the temperature is judged by feeling the inside with the hand and the pile re-built when necessary. The process is repeated two or three times at intervals of 5 to 10 days. If the leaves are ever found too dry during this operation they are sprinkled with straw dipped in water.

6. *The tobacco trade.*—See table at the end. The table speaks for itself as to the nature of the trade in raw and manufactured tobacco from 1900-01 to 1904-05.

7 and 8.—*Measures of Improvement taken in the past and Tobacco Experiments now in progress.*—These may be considered together. Last year a passed student of the Sibpur Agricultural class was deputed to Burma and Madras to see the methods of curing tobacco and manufacturing cigars. On his return he was put in charge of an Experimental Farm at Rungpur established chiefly with the object of utilizing the large quantity of tobacco that is grown in that district, for cigar making. A Madrasi cigar-maker was also appointed and it was proposed to start a class in connection with the local technical school for the purpose of teaching the art to the sons of cultivators. Some Sumatra tobacco was grown on the farm, and was cured as cigar wrappers, with some measure of success, by the Superintendent. Arrangements were made for growing a number of good cigar and cigarette varieties on the farm this year and seeds were obtained from America, Greece, Turkey, etc. With the transfer of the district, however, to the new Province of Eastern Bengal and Assam, this department has ceased to have any connection with the farm now.

9. *Measures recommended.*—The raiyats' methods of curing and fermentation are obviously very crude. It may be desirable to ascertain the possibilities of the existing varieties by dealing with them on scientific lines. For this purpose the best variety now cultivated (namely *hingli*) may be chosen. It will be also seen that the curing of this variety makes some approach to what it should be; and it is likely that really improved methods will meet with a ready welcome from the raiyats of Nadia and Jessore.

The points to which enquiry may be directed are:—

(*a*) priming the leaves;
(*b*) regulating the temperature and moisture of the curing shed; and
(*c*) regulating the temperature of the fermenting piles with thermometers.

All the three may be tried with this year's crop now growing. It will suffice to buy the raiyats' fields before they are harvested. If the experiment gives a negative result, that is, if proper curing does not produce any appreciable difference, the product may still be sold off at least for the money paid for

the raw leaves. But even the negative result itself would be of great value showing that for the European market new varieties must be introduced.

But there are difficulties. For though the plant grows almost anywhere the qualities of aroma, flavour, etc., are highly susceptible to soil and climatic conditions. The trade has been so highly specialised that it is little use producing a nondescript article. But there appears to be no foretelling without an actual trial where it will do and where it will not. The most important thing seems to be to ascertain first of all where good varieties would grow. It may be advisable to avoid building at any particular place curing and fermentation houses with all the necessary arrangements for regulating temperature and moisture in anticipation of success.

D. N. MOOKERJI,
Assistant Director of Agriculture.

Sea-borne Import and Export Trade of Bengal in Tobacco (value in rupees) during the quinquennial period ending 1904-05.

	Years.	IMPORT.					EXPORT.				TOTAL.
		Unmanufactured.	MANUFACTURED.			Total.	Unmanufactured.	MANUFACTURED.			
			Cigars.	Cigarettes.	Other sorts.			Cigars.	Cigarettes.	Other sorts.	
Trade with Foreign Countries ...	1900-01	893	1,72,063	11,04,762	6,63,202	19,40,920	53,704	36,061	...	28,803	1,18,568
	1901-02	...	2,14,064	13,84,526	6,29,969	22,28,559	2,17,950	47,051	...	34,340	2,99,341
	1902-03	396	1,99,349	15,21,365	6,15,920	23,37,030	1,12,521	31,158	...	28,581	1,72,260
	1903-04	1,056	2,15,280	19,94,344	4,82,988	23,93,667	45,544	31,028	...	32,357	1,08,929
	1904-05	1,036	2,37,493	21,07,217	5,30,992	28,76,738	1,57,919	20,942	...	29,224	2,08,085
Trade with Indian Ports ...	1900-01	5,90,504	2,85,850	...	12,955	8,89,309	20,35,219	1,091	...	64,143	31,00,453
	1901-02	2,41,103	2,61,326	...	13,962	5,19,391	31,22,893	1,454	..	54,321	31,78,668
	1902-03	1,90,622	2,70,693	...	15,221	4,76,536	28,78,854	2,111	...	49,148	29,30,113
	1903-04	3,63,594	2,01,714	...	17,679	5,82,987	25,54,788	721	...	67,160	26,22,669
	1904-05	95,656	2,38,565	...	20,078	3,54,299	31,91,739	2,303	...	77,996	32,72,038

Behar.

The area under tobacco in Behar amounts to 75,000 acres. Of this 48,000 acres fall in the districts of Muzafferpur and Darbhanga and 50,000 acres in those of Monghyr, Bhagalpur and Purneah. Within the last 2 years the area in Purneah has dropped from 30,000 acres to 3,000. This is attributed to low prices and jute competition. The distribution of the crop over these areas is very much a matter of the physical condition of soil. Thus out of the 48,000 acres grown in the districts of Muzafferpur and Darbhanga, 40,000 are grown inside or in the vicinity of the Samastipur Sub-division, and if we look further into the matter we shall find that the concentration is greatest in the Pergaṅah Saraisa, where the kind of soil known as *Saraisa Matti* prevails. The whole of the Behar trade is in native hands and the tobacco is grown entirely for native consumption. The origin of the plant grown in Behar is obscure. It is probably not indigenous to India and most likely was imported from America by the Dutch or Portuguese. It may also be taken to be, like most of the commercial plants in India, in a degenerated state. It is certain that very little can be made out of the Behar varieties as they stand at present for the European market. The varieties or races of tobacco grown are numerous, some being of heavy yielding quality, others being grown for their flavour. Some villages are in the habit of growing one kind, others another, so that at the end of the season, when the *Paikar* comes round to purchase stocks, he knows where to go for the particular quality he requires. The following names among many will indicate the principal types :—

Ghindheria	Large leaf.
Damakool	Large heavy leaves.
Boria	Small leaves.
Chooria	Long narrow leaves, noted for its flavour.
Kataya	Small leaves, noted for its flavour.

Cultivation.—Tobacco seed is sown in the month of August in raised beds, and the young plants are ready for transplanting by the end of September and beginning of October. The distance apart at which they are planted depends upon whether the variety is small or large, but is usually in rows 3 feet by 2 feet apart. Tobacco is a gross feeder and requires plenty of organic manure. This is put on during the rains in any quantity up to 20 tons to the acre, and the land kept fallow. It is hardly ever grown in land that has not been previously fallowed, and no completely satisfactory results can be expected without this treatment. The best crop in a rotation to precede tobacco is pigeon-pea (*Rahar*). When the plants attain a height of about 15 inches they are topped. The system of topping is different from that in vogue amongst growers for the European market. The native cultivators of Behar top their plants low and aim at fewer but heavier leaves, and so much has this been the practice in Behar, that only coarse leaf varieties are now to be found, unsuited for the European demand. Improved methods of curing would not remedy this defect, and if tobacco is to be grown here for the European market, a new plant must either be introduced, or one bred up by selection or otherwise, out of the present native varieties. Irrigation is seldom resorted to in these districts in years of normal rainfall, except in cases where the soil does not happen to be retentive of moisture.

Harvesting and curing.—When the plants are ripe, which is ascertained by a certain brittleness about the leaves, they are cut close to the ground and left to wilt in the sun. They are then gathered together and placed in heaps of 10 to 20 maunds and cured. The heaps are opened and made up again several times at intervals of 2 or 3 days, and during this process the stalks are cut off and the leaves tied together in small bundles. They are then finally packed in bales of 4 to 5 maunds, and sold to the *Paikars*. Two crops are taken off the land, the first cutting called *Moorhan* is of superior quality, and is exported to the west of India, while the second called *Donjees* is inferior and is usually

exported to the eastern districts. The first is sold at from R5 to R7 per maund, and some years as much as R10 is realised, while the latter only fetches R2 to R3 per maund. The yield of cured tobacco per acre is usually from 10 to 20 maunds.

Tobacco for European consumption.—Considering the adaptability of some of the soils of Behar for the growth of tobacco, one would have imagined that attempts to create a supply for the European market would have been numerous. It has, however, been otherwise. The only serious endeavour in this direction has been the work carried out at Pusa, when in the year 1874 on the closing of the stud farm, the Government leased this estate to Messrs. Begg, Dunlop and Company of Calcutta for the growing and curing of tobacco. It is much to be regretted that no reliable records exist as to the nature of the experiments; but it is admitted that as a commercial undertaking the experiment failed, the dry climate and the prevalence of dust being the chief reasons advanced for the failure. American experts in the curing of tobacco were engaged and many of the well-known American varieties were given a trial, but the bulk of the produce was of inferior quality, being used in the manufacture of plug tobacco and a cheap cigar for the English soldier. The limited supply of Pusa cigars and cigarettes of good quality which for a time were supplied to the public were known to have been made from materials not grown at Pusa. A second attempt on a much smaller scale was made by the writer in 1901 at Dalsing Sarai. Some of the best known varieties of tobacco seeds were procured from America, Java and elsewhere. Out of 20 kinds only 6 grew satisfactorily, gave a good yield, and supplied to all appearance the peculiar requirements of the tobacco trade. The kinds discarded were those known as heavy shipping varieties, of the class of golden leaf and Orinoko grown in America for pipe and cigarette. The leaves of these were excessively coarse and from an agricultural point of view were unsatisfactory and did not grow with the vigour noticed in the cigar varieties. These latter, on the other hand, did very well, and one variety especially, known as Zimmer's Spanish, could not be expected to do better, giving 1,840 lbs. of dried leaves per acre. It was thus clear that not all varieties would grow equally well in these soils, but that the most suitable are limited to a few, and these the cigar varieties. The experiments were, therefore, restricted to this kind and the second year they were grown on a more extended scale. The growth was again found to be all that could be desired, and arrangements were improvised for the drying and curing of the leaf, but the results obtained were not satisfactory. Samples of leaf were sent to London, but were found unsuitable owing to defects in drying and curing. The hot dry winds during the curing period and the want of knowledge in the drying and curing of the leaf were the chief difficulties in the way, and are sufficient explanations for the failure. The *growing* of a good leaf in Behar is, I am satisfied, an easy matter provided the correct varieties are selected, but the subsequent treatment to be successful must be carried on under *optimum* conditions in which the heat and moisture of the barn are under control. These conditions cannot be obtained in Behar naturally as in many countries of the world where the curing of tobacco is a success, but must be secured by artificial means. The attempts made at Dalsing Sarai in this line have proved inadequate for want of experience and scientific control and had in consequence to be abandoned. I have very little doubt that the failure in the Pusa experiments can be attributed to the same causes. The remedy seems to lie in the employment of a specialist to study the best conditions under which the leaf can be satisfactorily cured, and to obtain these by artificial means. It is to be hoped the Government may be successful in securing a man for the work.

Mention should be made of the raising of Sumatra leaf for two years at Dalsing Sarai under shade. The growth of the plant was everything could be desired, giving over 2,000 lbs. of leaf per acre, but the same was met with in curing as with other varieties.

B. COVENTRY,

Director of Agricultural Resea

Eastern Bengal and Assam.

The information furnished in this note regarding the cultivation of tobacco in different parts of Eastern Bengal and Assam is incomplete. The Department has very little information in its possession on the agriculture of the districts newly transferred from Bengal. The Superintendent of the Rangpur Experimental Farm has furnished some information which is embodied in this note regarding the methods of cultivation in vogue in the Rangpur district which is the chief centre of tobacco cultivation in Eastern Bengal. The information as regards tobacco cultivation in the Brahmaputra and Surma valleys is based on enquiries made by the Assistant to the Director.

The replies to the questions put by the Inspector-General of Agriculture are given as far as the information in the possession of the Department allows in the table annexed hereto. They relate to three separate tracts, namely, the Brahmaputra valley, exclusive of Goalpara, the Surma valley and Rangpur. Information concerning tobacco cultivation in the rest of Eastern Bengal is not available beyond certain reports furnished by District Officers in 1873 and contained in a collection published by the Government of Bengal in 1874. Tobacco cultivation is practically unknown in the hill districts of Assam.

Particulars.	Brahmaputra Valley excluding Goalpara.	Surma Valley.	Rangpur.
I.—The extent of tobacco cultivation in different tracts of the Province.	The area under tobacco in 1903-04 was returned as 1,285 acres in the five districts of Assam proper. This represents 0·07 per cent. of the net cultivated area of the five districts. The figure quoted above is believed to be less than the actual area, as much of the tobacco is grown in patches in homestead lands and escapes registration.	The greater part of the Surma Valley is permanently settled, for which no accurate crop statistics are available. The latest estimate places the area under tobacco in the valley at about 1,100 acres.	Rangpur is the most important centre of tobacco cultivation in Eastern Bengal. Accurate crop statistics are not available. The area under tobacco in the district in 1903-04 was estimated at 171,000 acres which is about 13·95 per cent. of the total cultivated area.
Whether the area is increasing or decreasing and the reasons thereof.	Not appreciably	Not appreciably . .	Believed to be extending in consequence of increasing demand from Burmese traders.
II.—The varieties of tobacco cultivated, their native names, the principal characters of each variety or race.	There are three principal races grown—(*1*) *Assamese* or *Jati*, (*2*) *Bengali* and (*3*) *Man*, *Burmese*, *Panpatiya* or *Palangpatiya*. The first two have large broad leaves. The Assamese is distinguished from the Bengali by having sessile amplexicaul leaves like Havana tobacco and has a milder flavour. The Bengali has a clean petiole. The third kind, as its name implies, is said to have been introduced from Burma. It is the same as the *Hamaku* of Rangpur and the *Gulpatta* of Sylhet. The leaves are small, of roundish shape, dark green in colour and somewhat crumpled in appearance. It is called *Panpatiya*, *Palangpatiya*, etc., from the fancied resemblance of its leaves to those of the betel (*pan*) and the *palang sale* (*Bela maritima*). It has small yellow flowers and is believed to belong to a different species (*Nicotiana rustica*) from ordinary tobacco. It is the coarsest tobacco known and is valued by the people for its strength.	There are two kinds known (1) ordinary tobacco or *tamak* with large broad leaves and (2) *hamak* or *Gulpatta*, the same as the *Man* tobacco of the Assam valley.	There are numerous varieties of tobacco grown in the district, but their distinguishing characters are not fully known. The principal are *Bhengi* and *Mani*, each of which has several sub-varieties. *Bhengi* has large broad leaves, almost as broad as long, while *Mani* is of comparatively slender growth, its leaves being narrower and of a lanceolate shape. Both of these cure to a brown yellowish colour and are liked by the Burmese. *Hamalen* or *Matikhari*, the same as the *Man* of the Brahmaputra Valley, is also grown to a large extent. Being of hardy habits and capable of growing on clay or paddy land, on which the better class of tobacco will not grow, its cultivation is said to be spreading in the district.
Any new varieties introduced and their progress.	None	None	None.

Particulars.	Brahmaputra Valley excluding Goalpara.	Surma Valley	Rangpur.
III.—Method of cultivation. Kind of land and soil in which tobacco is grown.	Tobacco is usually grown in small patches of well manured homestead land and occasionally in new alluvial lands on river banks. The soil is generally of a light loamy description. Clay soil is avoided for tobacco.	Same description of land and soil as in the Brahmaputra Valley.	High well drained land with light loamy or sandy soil, except that coarse strong tobacco is grown on low rice land of which the soil contains a large admixture of clay. High sandy soil is considered the best for tobacco.
Rotation . . .	No definite rotation of crops is observed as regards tobacco. In village sites the same land may bear tobacco for years.	Same remarks as for the Brahmaputra Valley. In places tobacco is grown on land that is used for growing rice seedlings.	As a rule, the same fields bear tobacco year after year. The better classes of tobacco are cultivated on land which bears no other crop during the year. The coarser kinds are grown on land which grows *aus* paddy or jute during the rains. *Hamaku* is sometimes grown on low land bearing earlier varieties of winter rice, after the rice crop is removed.
Preparation of the land .	The soil is reduced to a very fine tilth by repeated ploughing and ladderings. When the patch is very small the spade is used in place of the plough. The soil is reduced to a fine condition and every trace of weed is removed.	The same as in the Brahmaputra Valley.	The soil is reduced to the condition of dust by repeated ploughings and ladderings. All weeds are removed and the field is made as neat and clean as possible. Mallets are used for crushing such clods as escape the ladder.
Manuring . . .	Only homestead land is manured. New alluvial land being naturally rich requires no manure. Cow-dung is the only manure used. Ordinarily tobacco land receives no manure in the beginning. After the transplanted seedlings have struck root, a small quantity of fresh cow-dung is placed over the roots of each plant. But sometimes the field receives a dressing of old cow-dung during the ploughing season.	The land is heavily manured with cow-dung at the time of ploughing. Some cultivators also apply powdered cow-dung at the roots of the plants.	The fields are heavily manured with cow-dung and house refuse which are thrown over the land from time to time and worked in with the plough. When the plants are about two months old in the field, they are manured either with powdered rape cake at the rate of 6 to 10 maunds per acre or with well rotted cow-dung; only the richer cultivators can afford to use oilcake which has to be purchased.
Method of raising seedlings	Seedlings are raised on a few square yards of carefully prepared land ordinarily under the eaves of a house. In alluvial tracts, away from homesteads, seedlings are grown on raised beds protected by a cover from rain. The soil is pulverized with the hand. The seed is scattered over the bed and covered with about a finger depth of fine soil. To prevent ants from eating the seeds a little ash is strewn over the surface of the bed. No watering is given; nor is the soil manured. The usual time for sowing is the month of Bhadra	Seedlings are raised in very much the same way as in the Brahmaputra Valley. The seed is sown in October.	The nursery is prepared with great care. The soil is thoroughly pulverized and is heavily manured with cow-dung and ashes. It is divided into beds, each 8′ × 3′ and raised about 6 inches from the ground. Each bed (called a *pati*) is sown over with about a *tola* of seed which gives enough seedlings for a bigha (one-third acre) of land. No weeds are allowed to grow. The soil which is ordinarily very loose is pressed firm with the feet just as the seeds begin to germinate and the bed is kept covered with straw for a few days. The bed is watered

	(15th August to 15th September), but sowing may extend up to the first fortnight of October.		when necessary, in the evening. When the seedlings are about an inch high they are fit for transplantation. The sowing season extends over the month of September and the first fortnight of October. Occasionally seed is sown on small bamboo platforms resting on wheels which can be taken inside the house in rainy weather.
Transplantation . .	The time for planting varies within wide limits. At places it may commence as early as the middle of September and at others it may be continued up to the middle of February, but generally speaking the crop is planted during the last half of October and the first half of November. There is a belief in parts of Upper Assam that tobacco planted in *Pous* (15th December to 15th January) acquires a bitter taste. The plants are set down in rows at regular intervals which vary from 28 to 30 inches. *Man* tobacco being small in size is planted closer. This extremely coarse and hardy variety is occasionally grown on new alluvium by scattering the seed on the field, and after seedlings come up, they are thinned out to proper distances. This plan is economical and sometimes proves quite successful. For the first 3 or 4 days after transplantation, the young plants are protected from the sun by placing over them small pieces of plantain sheath during the day. The covers are removed at night. If the weather proves dry, the plants are watered every evening from a pot for a few days.	Transplanting takes place during the last fortnight of October and the first fortnight of November, but it may extend to the end of November. The earlier the operation takes place the better. The treatment as regards watering and shading is the same as in the Brahmaputra Valley.	The transplanting season extends from middle of October to middle of December. The field is laid out with parallel lines and cross lines, 20 to 30 inches apart, being thus divided like a chess board into little squares at each corner of which a plant is set down. The young plants are neither watered nor shaded, but in every sandy soil, if it happens to be too dry, the plants are watered from a pot till they take root. Vacancies are filled up with fresh plants as soon as they appear.
Subsequent cultivation .	The soil is kept clean and loose by light hoeings every 3 weeks or so. The practice for manuring the plants has already been mentioned.	The field is kept clean and the surface soil stirred from time to time, the spade being ordinarily used for this purpose.	The soil is kept perfectly free from weeds and prevented from baking by frequent interculture. The implements used for the purpose are a small plough drawn by the hand and a bamboo rake suited to the width of the interspaces between the rows, besides a small iron hand weeder and wooden mallets used for crushing clods. Interculture is continued as long as the plants are small enough to permit of the use of the implements without being injured.

Particulars.	Brahmaputra Valley excluding Goalpara.	Surma Valley.	Rangpur.
Removal of tops, side buds and bottom leaves.	The flower buds are removed as soon as they appear. Two or more of the lower leaves are removed at the same time. The lateral growths are pinched off as fast as they appear. As a rule 7 or 8 leaves are left on the plant to mature.	The same as in the Brahmaputra Valley. The number of leaves left on a plant varies from 5 to 10 according to the growth of the plant and the use for which the leaf is grown. For chewing tobacco (*sada*) fewer leaves are left than when the leaf is intended for smoking, the object being to impart more strength to the leaves.	The plants are treated in the same way as elsewhere. Generally 8 to 10 good leaves are left. Rejected leaves are known as *bisbat*, so called perhaps owing to their acrid taste and are considered to be of very inferior quality.
Irrigation	Unknown, except the little watering that is given in the beginning to help the plants to take roots.	Unknown except the little watering that is given in the beginning to help the plants to take roots.	Careful and well-to-do cultivators irrigate their tobacco from temporary *kutcha* wells dug in the field. The water is lifted by a lever arrangement and distributed by channels over the field. Irrigation does not begin till after the plants have been topped, and is continued at intervals.
Diseases and injuries	Cut worms are the only insect pests complained of. They destroy the young plants. The crop is often damaged by hail storms.	The same as in the Brahmaputra Valley.	*Insects.*—Cut worms do a great deal of injury to young plants. Similar injury is also caused by a species of beetle known as *Ghugri Poka* (perhaps *Diogryllus vimaculatus*). Aphides occasionally appear on the leaves; but they are not regarded as a serious pest. Tobacco curl is another disease of which the cause is not exactly known. The tobacco parasite (*Orobanche indica*) is occasionally seen, particularly in poor soil, but is not regarded as a serious pest in Rangpur. Frequent injury is caused by hail storms.
Harvesting, curing and sweating season.	The harvest extends from the middle of January to as late a period as the middle of May. Depending upon the time of planting and the character of the season, March and April may be said to be the usual time for cutting the crop. Ripeness is indicated by yellowish spots appearing on the leaves. As a rule no second crop is taken.	The harvest usually takes place in March and April. A second crop is taken if the weather happens to be fine for a few weeks after the first cutting.	The tobacco harvest commences about the end of January and continues to the middle of April. Ripeness is indicated by copper coloured specks on the leaves. No second crop is taken. The invariable custom is to prime, *i.e.*, to take off the leaves as they ripen. The leaves are severed with a

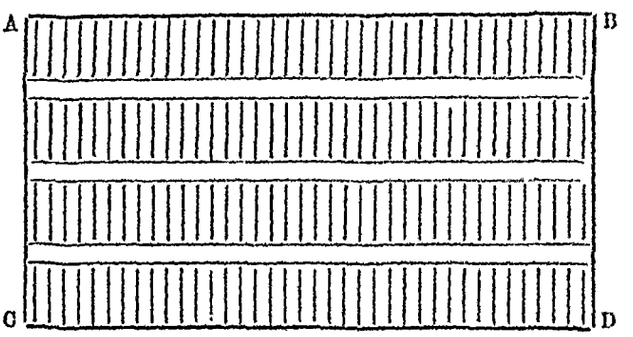
Mode of harvesting	The practice is variable. Some people gather whole plants, others gather the leaves individually as they ripen.	Whole plants are cut. Priming is unknown.	short bent knife, each leaf carrying a slice of the stem with it. The cutting is done in the morning.
Curing and Sweating	This usual mode of preparing tobacco which is in vogue in this valley is most unique. The tobacco so prepared is intended for chewing with the betel-nut. The method is varied to some extent, but consists essentially in rolling the green leaves and ramming down the stuff into a bamboo tube and allowing it to remain there till required for use. The following is an account of one form of the process furnished by an Assamese gentleman of the Sib-Sagar District:— After the leaves are stripped off the plants they are brought home and such of them as appear to be soiled with mud are washed with water. The leaves are kept in the sun for 2 or 3 hours to wilt. They are then placed in a basket and stored away for three days inside the house. At the end of three days, they are brought out, and the tendrils are crushed with a wooden mallet or iron hammer, after which they are rammed down into a large hollow bamboo tube. The stuff remains in this condition 3 or 4 days, at the end of which, as soon as the weather is fine, it is taken out and spread out on a mat in the sun. While it is drying, the stuff is rolled with the hands in much the same way as tea leaf used at one time to be rolled. This operation causes the juice of the tobacco to come out. These are taken up with the partially dried tobacco and not allowed to be lost. The tobacco has to be dried and rolled several times in this way until it becomes so dry that no more juice comes out on pressing. The dried tobacco is now placed in a basket lined with green plantain leaves and is covered over with more plantain leaves. It is taken inside the house and kept for three days in the basket. At the end of this period it is taken out again and pickled with a mixture of molasses and mustard oil in the proportion of a	No definite system of curing is practised. Some people cure the leaves in the shade and others in the open. The process of sweating in bulk is unknown.	The cut leaves are left for a few hours in the field to wilt, after which they are removed to a shady place, and are tied with thin bamboo slips into small bands of 4 leaves each. These are placed in the open over bamboo posts which rest on a light scaffolding erected outside the house. Here the tobacco is allowed to remain till the leaves are three quarters dry. This takes about a week. The next operation is to remove the leaves inside the house and hang them up in rows along the inside of the roof from poles placed across the house. There are no special curing houses, dwelling houses as well as cow houses being utilized for the purpose. Here the tobacco remains till the monsoon sets in, when it is taken down for sale to wholesale merchants. The ryots seldom do any sweating on their own account. This is done by Burmese and local merchants who prepare the tobacco for export. A note by Babu Jamini Kumar Biswas describing the method of sweating as practised by the merchants is appended hereto.

Particulars.	Brahmaputra Valley excluding Goalpara.	Surma Valley.	Rangpur.
Curing and Sweating—*contd.*	quarter *seer* of molasses and one *chattak* of oil to every *seer* of tobacco. The pickled tobacco is finally rammed down into the bamboo tube and it remains there till required for use. Most people however do not take much trouble in the matter. They content themselves by letting the leaves dry for a day or two in the shade and then ramming them down into a bamboo tube leaving the stuff to remain there till required for use. It is said the longer the tobacco is kept in the tube, the better it becomes for chewing. Some people cure the leaves by letting them hang from the roof of a house, but the process of sweating seems as yet unknown. Such tobacco is used for smoking in in the *chilum*.		
VI.—Trade . . .	There is no trade in locally grown tobacco. Most of the tobacco consumed in the valley is imported from Rangpur. The average annual imports and exports for the five years closing with 1903-04 were as follows:— Raw. Manufactured. Imports . . . 51,795 1,584 Exports . . . 534 22	Same remark as in the Brahmaputra Valley. The average annual import and export for the five years closing with 1903-04 were as follows:— Raw. Manufactured. Imports . 36,989 425 Exports . 54 17	Tobacco is largely exported from Rangpur. Part of the produce is exported to Burma. Eastern Bengal and Assam are largely dependent upon Rangpur for the supply of tobacco. The quantity annually exported is not known.

Particulars.	Remarks.
VII.—A summary of the measures taken in the past for the improvement of tobacco and their results.	An account of some early experiments with American and Cuban tobacco will be found in Part II of a Blue Book presented to the Houses of Parliament in 1874. These experiments produced no tangible results. The only experiment in recent years of which the Department possesses a record was one made by a Bengali Teaplanter, Mr. M. Holdar, at Monai in the Darrang District, in 1900-01 and 1901-02. The particulars of the experiment are not fully known. Two samples of the cured leaf were valued by Messrs. Spencer and Company at Re. 1 and 12 annas per pound, respectively.
VIII.—An account of the experiments now in progress and their objects.	The only place in the province where tobacco experiments are now being made is the Experimental Farm at Rangpur, which has recently been established chiefly for investigation connected with the cultivation and curing of tobacco. The experiments in tobacco on this farm have for their object the production of a leaf suitable for wrappers as well as for fillers. For wrappers, Sumatra tobacco is being grown partly under shade and partly in the open air. Two varieties of American cigar leaf tobacco and four of Grecian cigarette tobacco are also under trial. The curing will be done in a specially constructed barn. An expert cigar roller has been imported from Madras and is now engaged in preparing cigars from last year's crop of Sumatra tobacco. These cigars have turned out to be of fair quality. The experiment now in progress will be continued, and some well known varieties of American and Cuban tobacco will be tried. If the cigarette tobaccos turn out successful, cigarette making may be tried.

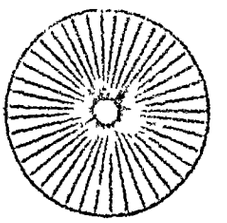
Note on Rangpur Tobacco.

The following system of heaping and sweating is practised by tobacco merchants in Rangpur. They purchase tobacco from the raiyats after it has been cured. The different kinds of bulking are practised. These are known as (1) Maiya gadi or Kata gadi; (2) Chua gadi; (3) Dhula gadi. In the Maiya gadi the bulk is divided into several rows 4 or 5 inches apart.



A horizontal section of a Kata gadi of 4 rows. Let A, B, C, D represent a bulk of 4 rows; in each row the butts are kept outside as it is made by placing one tobacco hand over another along the breadth of the row with the butts outside and the tops inwards. It is said that there is no fear of too much fermentation in this kind of gadi.

Chua gadi or Kua gadi.—It is made by arranging the leaves in a big circular heap with a small circular hole in the centre. In this the butts are outside as well as towards the central hole. It is made several feet and broad:—



A horizontal cross section of a Chua gadi.

Dhula gadi.—It is made in a compact mass with the butt outside. In this there is fear of too much fermentation. Inferior tobacco is placed at the top and bottom of each gadi which is made on a platform about 6 inches or more high. A gadi may contain 50 to 125 maunds of tobacco or more.

Maiya or Chua gadi is first made after the purchase of tobacco in *Jeth* or *Asar*. It is re-heaped at an interval of 10 to 12 days. The Dhula gadi is made after 2 or 2½ months and re-heaped at an interval of 7, 10 or 15 days as the case may be to prevent too much fermentation. A gadi when it is fit for being broken is said to be paka (ripe) by the local cultivators. It is tested by the peculiar odour as well as by feeling the temperature with hands. Profuse smoke would come out when too much fermentation takes place; and the stuff may get charred if not timely broken. If the tobacco is to be stored up the butts are moistened with a good tobacco decoction before making the Dhula gadi in *Kartik*. The solution is made by boiling 9,000 tobacco with *chittagur*. The head would be kept covered with a gunny and would not be broken any more.

JAMINI KUMAR BISWAS, B.A.,
Superintendent, Rangpur Farm.

BURMA.

Tobacco grown for European consumption.—None of the tobacco grown in Burma can be said to be grown specially for European consumption. Every one, European and Native alike, smoke Burman cheroots whether made of indigenous or Havana tobacco.

* * * * * * *

AREAS IN 1904.

District.	Acres.	District.	Acres.	District.	Acres.
Akyab	310	Northern Arakan	1,318	Kyaukpyu	2,804
Sandoway	1,916	Hanthawaddy	99	Pegu	1,002
Tharrawaddy	4,676	Prome	3,676	Manbin	3,532
Pyapon	15	Bassein	2,691	Henzada	10,582
Toungoo	1,550	Thaton	725	Amherst	32
Tavay	21	Mergui	355	Thayetmyo	5,907
Pakokku	4,906	Ninbu	2,948	Magwe	2,054
Mandalay	3,540	Bhamo	175	Myitkyina	229
Katha	1,056	Ruby Mines	174	Shwebo	240
Sagaing	2,458	Lower Chindwin	1,396	Upper Chindwin	760
Kyaukse	341	Meiktila	71	Yamethin	2
Myingyan	2,255	.....		.....	

AREAS IN 1905.

Akyab	350	North Arakan	1,398	Kyaukpyu	3,031
Sandoway	1,752	Hanthawaddy	106	Pegu	1,390
Tharrawaddy	5,858	Prome	3,684	Manbina	4,671
Pyapon	15	Bassein	3,318	Henzad	13,186
Myaungmya	3	Toungoo	1,134	Thaton	759
Amherst	40	Tavoy	1	Mergui	362
Thayetmyo	6,117	Pakokku	5,496	Minbu	4,204
Magwe	2,524	Mandalay	4,321	Bhamo, Myitkyina	1,725
Shwebo	180	Sagaing	4,171	Ruby Mines Katha	
Upper Chindwin	745	Kyaukse	577	Lower Chindwin	1,456
Myingyan	3,765	.....	...	Meiktila, Yamethin	51

	Acres.
Total areas 1903	57,015
1904	63,619
1905	76,390

Area is increasing: the reason assigned for increase in 1905 was "Island formations good—prices good."

2. The two main varieties are "Burmese tobacco" and "Havana tobacco."

Of the Burmese tobacco there are two main varieties "Se-ywet-gyi" or "Se-gyi," the large-leaved variety and "Se-ywet-gyun," a smaller-leaved variety with pointed leaves. The former yields a heavier crop, but the latter gives better quality. The Havana tobacco has been introduced by the Agricultural Department which has for many years annually distributed seed gratis for experimental cultivation. Virginia tobacco seed has also been distributed, but has not met with much success.

Methods of Cultivation.

3. *Henzada.*—Grown on low lands annually flooded. A high land portion of the holding is ploughed during *Wagaung* and about middle of *Tawthalin* seed is sown in nurseries. In 4 or 5 weeks time seedlings will be 3 or 4 inches above ground. During *Tasaungmon* and *Natdaw* seedlings will be transplanted into ground which has been ploughed 8, 10 or 12 *sa s.* Plants will be planted in furrows 3 feet apart with a 3 feet distance between plants. Gardens must be frequently weeded and kept clear. If soil is poor, plants should only be planted 3 or 4 years in the same place or blight will follow. After a rest of 2 or 3 years the holding may be planted again. In good soils annual planting may go on for 20 or 25 years. About a month after transplanting when the young plants have survived their first trials and are about one foot high, pruning of all small leaves should be begun and this process should be repeated till the tree has been cleared of all small leaves and twigs, 6 large leaves at least and 10 at most being left on. About *Tagu* plucking commences and is continued till rains break, but better that plucking should be over some time if possible before rains as these interfere seriously with the drying process.

Thayetmyo.—The soil is worked to a fine tilth by means of the '*ton*' and '*kyn-don*' and then a light furrow marker is drawn across the fields so that

parallel lines at intervals of about 2½ feet are plainly traced. In these furrows the seedlings taken from the nursery are set by women who prick a hole for each plant with a pointed wooden instrument and having poured a little water into the hole with a tiny ladle made out of the nut of the toddy palm, insert the seedling and press the earth firmly around it. Plants about 2 feet distant from each other.

Mandalay.—The richest blocks of *Kaing-kyun* are devoted to tobacco and onions. Although tobacco is grown in the dry months (December to April) it must not be supposed that it is a crop requiring little water. The amount of dew precipitated on all sorts of cultivation on river banks and islands is almost equal to a daily shower of rain. The broad spreading leaves of tobacco are particularly fitted for gathering dew and spreading it around the base of the plant. A few heads of each crop are allowed to run to seed to furnish seed for next season. The bazaar price of seed is 4 annas to 1 rupee *per zale.* The seed is sown in nurseries, the soil of which has been pulverized and usually manured. The bulk of seed required is small, 1 or 2 *pyis* to a *pe.* In most places in India the nursery is protected by a frame. This is not usually done in Mandalay. The seedlings are ready for planting out in January, *i.e.*, about 10 weeks after sowing. Rupee 1 per basket containing 1,000 is an average price for seedlings at this stage. The young plants are set out in drills 3 feet apart and the same distance (3 feet) is left between each plant in the drill. Number of plants to an acre therefore 4,000 to 5,000. Onions are occasionally planted between the rows, but this is considered bad husbandry as interfering with hoeing, weeding, etc. Previous to the planting out the ground is run over with a 7-toothed harrow to work in weeds, old leaves, etc. It is then ploughed with a 1-strand plough to turn up the sub-soil, then with a 4-toothed harrow to break the lumps. These operations must be continued until the soil is thoroughly pulverized. It is then levelled with a *Kyandon* (clod-crusher) which hardens the surface soil and prevents evaporation from the sub-soil. The seedlings are about 6 inches high when planted out; after 3 months they have become 18 inches and are pruned, the tops of the plants are docked and all suckers and buds are topped off. These off-shoots are too bitter to be used for smoking and are left on the ground.

Minbu.—Tobacco cultivated in same way as described above for Mandalay. The richest lands are devoted to it. In some places where the soil is covered by a layer of sand the mode of cultivation is peculiar. Cultivator works a hole in the sand with a heavy iron bar until the rich alluvial deposit underneath is reached: fills hole with good soil and plants a seedling. This is done in December or early January. The plant instead of throwing horizontal roots, sends one root downwards which fixes itself in the alluvial bottom and from which it thereafter derives its sustenance.

Sagaing.—Tobacco is grown on the best island land, finely divided alluvial clay without excess of sand, which usually lies in slight hollows and is the last to emerge when the water falls. Nurseries are sown beyond the reach of the river, often in the cultivator's own compound, from October onwards, and planting out begins in December. The seedlings are set a few feet apart, usually in shallow holes, over which a little thatch shelter is placed for some days to protect the plants from the sun. For the first few days they are watered until they have recovered from their drooping condition. When, as is often the case, there is a considerable layer of sand above the clay, a pit is dug in one corner of the field from which clay is extracted and spread over the surface and placed in the holes prepared to receive the plant. This prevents them withering off and dying before their roots can penetrate through the sand to cool clay below. From time to time during the growth the central leaf-bud at the top of the plant is pinched out by hand in order to throw the strength into the leaves, to discourage blossoming, and to prevent any tendency to straggling growth. Three or four of the lower leaves and some of the side shoots are also removed to strengthen the remaining large leaves.

4.—*Diseases, Insect Pests, etc.*

Henzada.—Many insect pests. Before plant has made any progress and just when young shoots are sprouting, *Po-nga, nangyaung, pa yit-gyi, payit-kale*

attack roots and leaves and necessitate re-planting. *Khu*, a hairy caterpillar, attacks leaves when plant is 1 foot above ground. *Pya-gaung*, or sand-fly, attacks leaves and the *Po-sein*, or green caterpillar, *Teik-po* and the *Daungde-po* attack bud and leaves, while the *O-shank-po* gets inside the stalk and *Myit-pyat-po* attacks the roots. These pests are most common when there is heavy dew or in cloudy weather before and at the commencement of the rains. In addition to insect pests the stalk of the plant is not infrequently attacked by blight, especially in dry and poor soil.

Mandalay.—Authorities on tobacco cultivation insist on the instant removal of injurious insects, but the tobacco grown on the *Mandalay-kyuns* suffers no damage to its leaves by insects. Want of rain is the alleged cause of these leaf-eating insects, but the heavy dews near the Irrawaddy presumably serve the same purpose as rain in preventing the hatching of any eggs or larva that may survive the annual floods. The roots, however, are sometimes attacked by worms.

Drying, etc.

Henzada.—In Hlezeik the custom is to press out the stalk flat and then dry the tobacco in a strong sun, which is done in one day under favourable conditions. In Yegyi township tobacco is hung up on bamboos for 15 or 20 days in the house and then put 4 or 5 days in the sun to dry the stalks, etc., thoroughly. In Lemyethna township the tobacco is hung up on a raised platform for 4 or 5 days, and when slightly dried the process is completed in the shade.

Prome.—Tobacco inferior and dried by spreading on the sand in the sun.

Thayetmyo.—The coarse tobacco is merely dried on bamboo frames, the leaves being laid about three deep and a second frame being placed over them to keep them in position while sun and air cure them. In some few cases the leaves are more carefully dealt with and are hung up in bunches in small sheds, or at all events out of the sun, and are allowed to ferment and become cured in the orthodox way. The fine-leaved tobacco is often twisted up as soon as the leaves are pulled and cut into fine shreds by means of an old *dah*, fastened near its point to a post in such a way that it can be used as a lever knife to cut what is placed on a block below. In this case the fine-cut shreds are laid out on mats to the thickness of about 2 inches and are kept there for a few days and turned at intervals until they are uniformly dried and cured.

Sagaing.—The leaves are picked in March and April, and after as much of the sap as possible has been pressed out by means of a roller and a board, are spread in the sun to dry. No process of curing or fermenting is attempted. The stalks are also dried and shredded up and are made as much use of as the leaves.

Mandalay.—After plucking, the leaves are sun-dried for one day. Some cultivators have adopted the shade-drying process, but sun-drying is preferred as being quicker. Sun-dried leaves fetch a slightly higher price as they are of a yellow colour, whereas shade-dried leaves are said to be black and rank and unsaleable. This may hold good as regards the Burmese market. The American method of packing in layers and drying gradually has proved itself to be the best, but it requires special experience.

Additional Information regarding Outturn, etc.

Minbu.—Assumed outturn 200 viss, 40 baskets of stalk.

Mandalay.—Outturn by local enquiry :—

171 to 342 viss per acre of leaf.
114 to 285 viss of stalk.
R25 for leaf, R10 stalk per 100 viss.

Henzada.—Prices—Lemyethna R40 per 100 viss shade-dried; if kept a year, R120 to R130.

Seyo for filling Burman cheroots R35 to R40 per 100 baskets; if chopped and pounded, R90 to R95.

Hlezeik R29 per 100 viss Burmese tobacco sun-dried; R30, *seyo*, Indian tobacco of Ngathainggyaung, dried in shed, R35 to R50, while Burmese only R25 to R30. Average number of plants to acre 4,945 with 38,361 leaves. Gross weight 5,945 lbs., and dry 1,263 lbs., and about 43 baskets of *seyo*.

Prome.—Outturn about 200 viss per acre.
Thayetmyo.—Outturns 250 viss but up to 400.

The Department of Agriculture has distributed Havana and Virginia tobacco seed, but no other experiments are in progress. It is impossible to frame a programe at present, but it may be stated generally that what is required is improvement in the methods of curing, which are at present extremely primitive.

United Provinces.

1. The crop is not of great importance in these provinces, and its cultivation appears to be practically stationary. The areas are—

	Average. 1893—95.	Average. 1903—05.
Area under tobacco	62,700	67,000
Percentage of cultivated area	0·2	0·2

The districts with the largest area are—

	Acres.
Meerut	4,400
Bulandshahr	5,100
Aligarh	7,600
Farukhabad	6,000

In no district does the area under tobacco exceed one per cent. of the cultivated area.

2. The varieties of tobacco grown in the provinces have not been studied recently: they were grouped by Fuller and Duthie under *Nicotiana Tabacum* and *Nicotiana Rusticum*. The following note embodies the observations of the Assistant Director (Mr. Muhammad Hadi, M. R. A. C.):—

"The varieties are as follows:—

(1) *Desi, Maghi, Mahun, Mahya or Gethau.*
(2) *Gallar.*
(3) *Dhaturya, Vilayete, Calcuttia or Hathikan.*
(4) *Kapila.*
(5) *Dakha.*

Besides these there is another variety known in some districts as *Bansi* and in others as *Khagurya*, but it is not important—

(1) *Desi.*—This variety is known under different names in different districts, *e. g.*, *Desi* in all western districts, *Maghi* in North Oudh, *Mahun* in Rohilkhand, and *Mahya* in many of the central Doab districts. It has been cultivated in these districts for a very long period. Its leaves are ovate and large. It is not very strong for smoking.

(2) *Gallar.*—This is grown mostly in the Meerut Division. Its leaves are thick and rough, and its stem bulky. It is said to have been imported from Kabul about 150 years ago. Its leaves are ovate.

(3) *Dhaturya.*—It is stated that about eighty years ago the seed of this variety was brought in these provinces from Kabul. This is very strong and its outturn is about 25 per cent. more than those of two varieties mentioned before. The leaves are very much adulterated by shopkeepers with foreign matter which gives more profit to them. In appearance it resembles the *Gallar* to a certain extent. It is so called because it is believed to be as porwerful a narcotic as *Dhatura*. In the north of Oudh and eastern districts it is called *Calcuttia*. In Rohilkhand it goes by the name of *Hathikan*, in western districts by the name of *Dhaturya* or *Calcuttia* and in some districts by the name of *Vilayete*. Its leaves are round.

(4) *Kapila.*—The seed of this variety is said to have been imported from Kabul about thirty years ago. It resembles *Dhaturya* in quality, but not in shape and size. Its leaves and stem are harder than those of *Dhaturya*. It is grown only in the Meerut

Division and requires abundant irrigation and manuring. Its leaves are ovate.

(5) *Dhaka.*—This variety is largely grown in the Agra Division. It is so called because its leaves resemble those of Dhak (*Butea frondosa*). It is stronger than the *Desi* variety, but milder than *Calcuttia* or *Dhaturya*. It does not require so much watering as *Dhaturya*. It is used for chewing as well as for smoking. It resembles very much the *Dhaturya* variety. Its leaves are round."

3. Tobacco is grown (1) in the heavily manured land close to villages; (2) on the sites of old towns where the soil and well-water are rich in nitrates; (3) rarely in virgin soil in the forest tracts. It is sown in nurseries, which are tilled garden-fashion, and is planted out at different times in the year from July to February, and harvested from February to April. As the crop is grown mainly in garden cultivation with heavy manuring, the rotations are extremely varied: but where nitrates abound the crop is grown for several years successively on the same land; and where poudrette is readily available, the commonest rotation is maize-potatoes-tobacco, all within the year, this course being repeated annually. The tillage is the best that can be given, and the first operation is frequently to dig the field a foot deep; after this the soil is completely pulverized by the usual implements, and the seed-bed is usually a very satisfactory production. After transplanting the land is kept loose and free from weeds with a hoe. All flower buds are nipped off (except on plants reserved for seed), and lateral branches or shoots from the leaf axils are removed as soon as formed.

In a few places the nitrates in the soil and the water give sufficient plant-food, but usually from ten to thirty tons per acre of cow-dung, sheep-dung or poudrette are applied: the manure is worked into the soil very thoroughly. Crude saltpetre earth is often applied as a top-dressing where the water available is not salt.

The plants are usually watered by hand just after transplanting. After this water is run on to the fields as required: about 20 waterings with ordinary water, or 15 with water from salt wells, are usually needed. Every effort is made to get water from salt wells, and such water is often led a long distance to the fields. When ripe, the leaves are stripped from the plant, or else the whole plant is cut down to the ground; the crop is dried in the sun and then stacked under cover. The drying is carried out on the field, the leaves being turned over every second or third day. After a period that varies greatly in different localities, the crop is carried home for fermentation. The leaves are now separated from the stalks if this has not been done in the field; but with the *Calcuttia* variety the stalks are not always separated. The leaves are stacked in a mass and left for a varying period, being sprinkled occasionally with brackish water or with a decoction of the stalks; it is said that the latter treatment makes the tobacco stronger. The temperature is watched carefully and the heap opened when necessary. Finally, the leaves are twisted into coils and are then ready for sale.

4. The diseases and pests that affect tobacco in these provinces have not yet been studied in the laboratory. The following note embodies the field observations of the Assistant Director:—

"*Fungus Diseases*—

(*a*) *Kabra, Chitka or Chunaria.*—This is a fungus disease in which spores develop and form white blotches on the blades of leaves and destroy the leaf.

(*b*) *Sargudda.*—This appears when the plants are young but transplanted. It affects chiefly the *Calcuttia* tobacco when there is abundance of winter rain and the latter is followed by fog. In this disease the leaves rot and fall down. *Maghi* tobacco also suffers sometimes from this pest.

(*c*) *Moria.*—In this disease the leaves become curved and shrivelled.

(*d*) *Dahia.*—In this disease a sticky substance is produced on the leaf, causing it to wither.

(*e*) *Umsa.*—In this disease the plants dry up.

Insect Pests—

(1) *Bot.*—This is an insect which destroys the plant when it is young. It eats away the leaves and generally appears in dry weather. To protect the nursery crop from this insect the cultivators cover it with a light frame-work made up of *payal* (rice straw).

(2) *Sundi.*—A caterpillar. This grub injures the plants by cutting them at their roots.

(3) *Mahu.*—This insect feeds upon leaves. It injures the crop generally in cloudy weather. Ashes are applied as a remedy."

5. The primitive methods of drying and curing have been described in paragraph 3.

6. The provinces do not supply themselves fully with tobacco: during the last five years imports (all sorts) have averaged 300,000 maunds against about 80,000 maunds of export. Practically the whole import (excluding small quantities of cigars and cigarettes—about 1,000 maunds in all) consists of leaf, most of which comes from Bengal.

7, 8, 9.—No experiments have recently been tried for the improvement of Indian tobacco, and it will be some time before the Agricultural Department can turn its attention to this crop, as many more important staples claim precedence.

Note on the European Tobacco in the United Provinces of Agra and Oudh.

No tobacco is known to be grown or manufactured for European consumption in the provinces. Efforts were made in the seventies to establish this industry, and a tobacco farm was started at Ghazipur; the farm was soon leased to a European firm who brought out a curer from America. The conclusion drawn from the early experiments was that the provinces, except the extreme eastern fringe, were unsuitable for tobacco operations on a large scale: the reasons assigned were: (1) the danger from frost and hail; (2) the dryness of the climate, rendering constant irrigation necessary, and making it difficult to regulate the temperature during the curing-period.

The firm continued the production of tobacco on a commercial scale, and with a succession of imported experts, till 1889. The same firm had a factory in Pusa at about the same time. Their reasons for abandoning the industry were stated by them as follows:—"Experience showed that the nature of the climate and soil at Ghazipur and Pusa, and the conditions under which curing operations have to be conducted, are not adapted to the turning out of leaf of a quality fit to compete with the finest American.

"At Ghazipur especially, owing to the dry climate, the light character of the soil, and the strong winds which prevail, the tobacco gets covered with sand which greatly prejudices the leaf in the estimation of English buyers.

"Large shipments of tobacco grown in the last six years were made to England, but owing to defects resulting from the causes stated above the leaf was graded with the medium and lower qualities of American, and the prices realised so far have been very disappointing: a considerable portion, however, still remains on hand, and latest advices received from our brokers are that the lot may have to be kept for another two years and will then probably not realise sufficient to cover the cost of production.

"The factory established at Pusa has also proved disappointing. It was soon discovered that cake tobaccos and smoking mixtures made entirely of Ghazipur and Pusa leaf could not compete with those of English and American manufacture, and American leaf had to be imported for wrappers and for mixing. This added considerably to the cost of the manufactured tobaccos, and although the quality of these has been improved so that there is a limited sale for them, progress has been slow and the quantity disposed of has not hitherto been sufficient to make the business profitable."

It need only be added that *the defects of climate, etc., enumerated in the* case of Ghazipur exist in a much greater degree in the rest of these provinces. If they are real hindrances, a point on which my information is defective, they are conclusive regarding the provinces as a whole, since liability to frost, hail, dust, west winds and low humidity is less in Ghazipur than elsewhere in the provinces.

American tobacco was tried in the Himalayas about 1880 and was a complete failure, but the actual causes of failure are not on record.

W. H. MORELAND, I.C.S. C.I.E.,
Director of Agriculture, United Provinces.

PUNJAB.

The improvement of Tobacco.—Tobacco has not been taken up by the Provincial Department as yet. I have very little special knowledge on the subject, and was at first disposed to send no report at all. But as replies are invited from the whole of India, I have thought it advisable to collect and summarise briefly such information as is already available and which has not already been incorporated in the Dictionary of Economic Products.

I.—*The extent of tobacco cultivation in different tracts of the Province.*—The total area matured under tobacco in 1904-05 was 58,818 acres. It is grown mainly in the Central Punjab and in submontane tracts. The area has increased slightly in the last 3 years, as appears from the following figures:—

	Acres.
1902-03	51,095
1903-04	53,568
1904-05	58,818

For questions (2), (3), (4), (5), I think I cannot do better than refer you to Watt's Dictionary of Economic Products, Volume V. The information found there is compiled mainly from the District Gazetteers.

II.—(*a*) *Varieties cultivated*, and (*b*) *New varieties introduced.*

(*a*) See Watt's Dictionary, Volume V, page 402.

(*b*) *New varieties introduced.*

In the Kangra District American and Havanna leaf has been raised by a European planter, but its manufacture has not been attempted on a large scale.

In 1899, Virginia tobacco seed was distributed to a few prominent cultivators in the various districts for experiment. In some cases total failure was the result. In others, the plants germinated fairly well, but the leaf did not turn out satisfactorily, having a shrivelled up appearance. In a few cases, where the plant reached full maturity, complaints were made about the flavour of the leaf. The trials were made without supervision of any kind and are inconclusive.

Two American varieties, Conqueror and Bonanza, were tried at the Lyallpur Farm in 1901-02. The following is taken from the Manager's report:—

"The plants of both varieties thrive well and attain a height of 5 and 6 feet, but the stalks are very thick. On the whole the outturn is very good and the varieties can be recommended. The total outturn of cured leaf and stalk per acre was—

	Lbs.
Conqueror	1,016
Bonanza	1,188

"Some leaves from each variety were cured according to American methods by artificial heat. The tobacco was placed in a room and heat applied by burning fuel in an ordinary furnace. It was not possible to regulate the heat properly, but the colour of the leaves was good."

III.—*Methods of tobacco cultivation, tillage, preparation of seed-beds, transplanting, manuring, hoeing, suckering, topping, irrigation (including use of salt wells), harvesting, rotations, etc.*—See Watt's Dictionary, pages 403 and 404.

IV.—*The fungus diseases, insect pests and plant parasites of tobacco.*—Watt's Dictionary, page 376.

V.—*Methods of manufacture, drying and curing.*—Watt's Dictionary, pages 402 to 404.

VI.—The tobacco trade, exports and imports, etc. :—

1. *Imports.*—

	Mds.
(*a*) Unmanufactured	48,812
(*b*) Manufactured	646

2. *Exports.*—

(*a*) Unmanufactured	19,337
(*b*) Manufactured	53

W. C. RENOUF, I.C.S.,
Director of Agriculture, Punjab.

BOMBAY.

The extent of tobacco cultivation—Is given below for the year :—

Year.	Acreage.
1900-01	74,803
1901-02	94,527
1902-03	85,428
1903-04	80,414

Of the total acreage about 25 per cent. is in the Kaira District and 30 per cent. in the Belgaum District. The acreage is apparently decreasing in the Kaira District (owing to bad seasons) and the same remark applies (but for the past two years only) to the Belgaum District.

2. Only one *tobacco variety* is apparently grown and no special name is therefore applied. New varieties have previously been tried, among other places, at Nadiad, but have failed.

3. *The methods of cultivation* are given in Mr. Mollison's Text Book.

4. No *Fungus diseases* are common ; *insect pests* are white ants and the leaf worm (*Prodenia littoralis*) ; the plant is attacked by broom rape.

5. *Method of curing, etc.*, is described in the text book mentioned.

6. The tobacco trade is in all cases local and all tobacco is for local consumption in the form of smoking and chewing tobacco and snuff.

7. Past measures include extensive experiments in varieties, curing, etc., of tobacco carried on at Nadiad by private agency aided by supposed experts, but the results are negative and details are not on record. The installation included curing and fermentation houses, tobacco cutting machinery, etc.

8. *Experiments now in progress* at Nadiad include the growth of varieties, hybridization, curing and fermentation. For the latter processes special buildings are being erected. Object of the experiment is to secure leaf suitable for manufacturing into tobacco for European consumption.

9. *Tobacco for European consumption* is not grown in the Presidency.

F. FLETCHER, M.A.,
Deputy Director of Agriculture, Bombay.

MYSORE.

The average area under tobacco during the past 18 years has been 17,352 acres out of the total of about 5,685,000 acres under cultivation, or about 3 per cent. of the arable land under cultivation. The principal troubles which have come to my notice were the aphis and the parasite *Orobanche nicotianæ* ; for the former I have used kerosine emulsion to good advantage ; with the latter I have comparatively little experience. The tobacco is cured on the field ; is used for native consumption ; and the only sample I had valued by an European tobacco firm received a very unfavourable report.

The area under cultivation has of late years increased a little, but has been fairly constant during the past 10 years. For the 8 years preceding this period, the area varied from 55,000 to 2,000 acres.

A. LEHMANN,
Agricultural Chemist to the Government of Mysore.

APPENDIX D.

PAPERS REGARDING LEGISLATION FOR THE CONTROL OF COMMERCIAL FERTILISERS IN INDIA.

Proceedings of the Board of Revenue, Madras (Settlement, Land Records and Agriculture), No. 4674, dated the 1st December 1905.

Read the following letter from the Deputy Director of Agriculture, No. 2888, dated the 18th November 1905 :—

In reply to paragraph 5 * of Board's Proceedings No. 312, dated the 7th October 1905, I have the honour to report as follows. * Attached.

2. The necessity for using artificial manures is already being felt to some extent in this country, though so far the actual utilisation of such fertilisers is for the most part confined to the "planting" industry. The demand for such manures is one that should be encouraged, especially as their use connotes more and more intensive cultivation; but this cannot be done advisedly unless the composition and character of the artificial manures put on the market be known and can be depended on. As an instance of uncertainty as to composition, I need only refer to the correspondence, I submitted with my letter No. 2595, dated the 19th October 1905. As showing what is considered necessary and advisable in the United States in the matter, I would refer to the article "Inspection of Fertilisers," given at page 466 *et seq.* of the appendix in the volume entitled "Agricultural Experiment Stations in the United States," dated 1900.

3. Unless the persons who may be consulted about different manuures put on the market have a means of ascertaining their actual composition, they cannot give useful advice, and for advice to be of value the composition must be uniform in each case. In this country far more than in the United States, the ryots of all classes who may be approached by the plausible agents of manufacturers, or even with circulars prepared with a parade of scientific detail which only causes confusion, need very definite advice. For this, this Department must be directly or indirectly responsible as regards novelties, and the very best advice procurable should be given by it in such a matter as the use and value of artificial manures. The urgency for giving this matter attention is likely to be greater as the local Agricultural Associations begin to move and enterprising members desire to make new departures—at present the fashion of the day is in the direction of oil-engine pumping, but fashion's fads change; and if this one is successful, it cannot fail to stimulate a demand for manure. The supplies of natural manure in this country can only be expanded slowly to a limited extent, and ultimate recourse will have to be had to artificials.

4. As I have already said, a start in this direction has been made, and irreparable harm is possible and probable if the people are induced by any means to invest in bad or unsuitable manures. Exactitude as to the manures suitable in various cases is not at present, owing to the absence of experiment and research in the past, possible, but the people can at least be protected from fraud and imposition in respect of the manures placed on the market. A few failures in the use of artificial manures will set back the use of such in any locality for a long time to come, and deter the enterprising from making experiments, and such failures must inevitably follow the use of fraudulent or bad manures. What I urge, therefore, is that the Government should obtain powers to inspect and control the business. This can be done by passing a simple Act on the lines of those summarised in the book above mentioned, and committing the work of inspection to the Agricultural Chemist of the new Research Station. This work should be self-supporting.

5. In my opinion the lines of the "Connecticutt Fertilizer Law" summarised at page 467 of the book may be followed; but the remarks given at page 479 as to the points to be specially considered should also receive attention.

6. Finally, I would suggest that the general question of whether it is advisable for the Agricultural Department to undertake the inspection and control of artificial manures might be referred to the Board of Agriculture at

its next meeting in January next, and also to such bodies as the United Planters' Association of South India and the Central Agricultural Committee.

Reference thereon, No. 4674, dated 1st December 1905.

A copy of the letter from the Deputy Director of Agriculture read above will be forwarded to the Inspector-General of Agriculture, with the request that he will, if he sees no objection, refer to the Board of Agriculture, for consideration at its meeting in January next, the question whether it is advisable for the Agricultural Department in India to undertake the inspection and control of artificial manures, and if so, whether legislation of the kind suggested by Mr. Benson should be undertaken.

2. Copies of the letter will be referred to the United Planters' Association of South India and to the Honorary Secretaries to the Central Agricultural Committee for report on the above points.

L. W. SWAMIKANNU,
Acting Secretary.

To the Inspector-General of Agriculture in India.

* * * *

Extract, paragraph 6, of letter No. 2364, dated the 26th September 1905, from C. Benson, Esq., M.R.A.C., Deputy Director of Agriculture, Madras, to the Secretary to the Commissioner of Revenue Settlements and Director of the Department of Land Records and Agriculture (quoted in Proceedings No. 312, dated the 7th October 1905) of the Board of Revenue, Madras.

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6. A further point which came under my notice whilst in the district is the fact that some mirasidars have been induced to buy artificial manures at considerable prices, whilst there is no one to guide them and no law in this country to protect them in such matters. The local Association is not able or qualified to do this, although it might no doubt do something in the matter of obtaining such manures at reasonable rates if it purchased them wholesale, and the only course that I see is that this Department should step in and secure control of the matter. It is of the utmost importance, and especially in these days when a beginning is being made in this matter, that the average purchaser should be protected from any fraud in such things as artificial manures, and it is a well-known fact that the trade in artificial manures is full of fraud in most countries.

Extract paragraph 5 of Proceedings No. 312, dated the 7th October 1905, of the Board of Revenue, Madras.

* * * * *

5. In regard to the facilities required for obtaining good artificial manures and the securing of control in the matter, the Deputy Director is requested to submit a detailed report in due course.

Note on the English Fertiliser and Feeding Stuffs Act of 1893.

Under the provisions of this Act the County Councils and Boroughs were authorised to appoint analysts, and the Board of Agriculture and Fisheries, a chief analyst, for the purpose of determining the composition of such samples of fertilisers and feeding stuffs as were submitted by the purchaser; the samples being taken in accordance with certain prescribed rules. Prosecutions may be instituted by the purchaser or the local authority, or by an Association which may be authorised by the Board.

A Departmental Committee was appointed in 1904 by the President of the Board to enquire into the working of the Act, and its chief conclusions may be briefly summarised as follows :—

(*a*) It was found that, while the Act had been beneficial to the large purchaser, the small farmer had been benefited to only a minor degree because of the comparatively large expense he is put to when attempting to use the provisions of the Act, and because of the difficulty he has in complying with the required procedure when taking the samples. The Committee recommend that to meet this, the local authorities should be empowered to utilise public funds for the purpose of providing official samplers, and also to pay for analyses of samples taken on their own account. That the official samplers should be empowered to take "test samples" (19), not necessarily in accordance with the Regulations, with a view to the location of fraud.

(*b*) The Act of 1893 exempts quantities of less than ½ cwt. from the provision of section 1. The Committee recommend that this clause shall be removed and also that poultry food shall be included.

(*c*) The Act provides that a minimum percentage of the several constituents shall be stated in the guarantee. In order to meet this, dealers have inserted figures in the statement of composition far below what is or should be present, thus rendering the warranty useless (28). The Committee recommend that the Board should issue a statement of limits above or below the guarantee, within which the constituents of each of the principal fertilisers and feeding stuffs may reasonably be expected to vary from causes beyond the seller's control. That the seller shall be required to state the actual constituents present.

DR. J. W. LEATHER, PH.D.,
Agricultural Chemist to the Government of India.

Digest of the Fertiliser Laws of the United States of America.

The details of the different laws controlling the sale of fertilisers in the United States of America vary considerably in different States of the Union. But the principal point requiring every package of fertiliser controlled by the law to be properly labelled is the same in each case. This label requires to give the name and address of the manufacturer or his agent, the net weight of fertiliser contained in the package and the composition of that fertiliser. The form in which the composition is to be given is generally prescribed by the law. It varies a little for different states. To have as much uniformity in this point in the laws enacted by the various states and to offer suggestions on other points connected with the Fertiliser Laws, a representative committee composed of manufacturers and official chemists was called together. It recommended that the composition of fertilisers should be given in the following order and form :—

Per cent. phosphoric acid soluble in water.
Do. Do. reverted.
Do. Do. insoluble.
Do. Do. total.
Per cent. nitrogen in nitrates.
Do. Do. ammonia.
Do. Do. total.
Per cent. potash soluble in water.
Per cent. chlorine.

Only one figure to be given for each item; for chlorine the maximum and for all the other constituents the minimum of the quantity actually guaranteed. The substances not contained in the fertilisers to be left out of the list. Excepting very slight differences this list meets all the requirements of

most of the existing laws. A special provision is made in many laws to exclude leather, hair and wool from fertilisers unless special mention is made of the fact that they are present.

The person called upon to control the sale of fertilisers is generally called Inspector of Fertilisers and is generally either the State chemist, the chemist of the State Experiment Station, the Professor of Chemistry at the State Agricultural College, the Director of the Experiment Station, the Secretary of the Board of Agriculture, or the Commissioner of Agriculture, and he is permitted to delegate the actual work to any of his assistants or subordinates whom he considers competent.

As the laws stood two or three years ago, the manufacturer or his agent had in most cases to send a truly representative sample (in sealed bottles) together with a statement of its composition to the Inspector when applying for a licence to sell that fertiliser in the state. But the Committee mentioned above considered it unnecessary to send that sample.

The duty of the Inspector is, in addition to granting licences, to cause to be collected and analysed each year at least one sample of each fertiliser offered for sale and to publish the results in a bulletin. Generally he or some other of the officers named above is called upon to prosecute fraudulent dealers, those who either sell without licence, or offer for sale fertilisers not duly labelled, or fertilisers which do not come up to the guaranteed standard. The purchaser is seldom called upon to prosecute, but may, in some of the states, demand a compensation amounting to the full price he paid for the fertiliser: in some states double the amount is granted as compensation and in one state the law provides that he may demand four times the amount of the price paid for the fertiliser if it falls short of the guarantee. In some states the manure is confiscated and in others fines are imposed for breaking this or other part of the law.

In two states the law prescribes that if any fertilisers drop 1% or more below the guaranteed standard in either phosphoric acid, potash or nitrogen that shall be considered as indicating fraud. Another state, New York, prescribes that if a fertiliser drops $\frac{1}{3}$% below the figure given on the label for nitrogen or $\frac{1}{2}$% below the available phosphoric acid or water soluble potash, or one per cent. below the total phosphoric acid given on the label it shall be considered a fraud.

The inspector or his representative may sample any fertiliser anywhere he meets with it, but must observe certain rules in sampling.

In many states all fertilisers sold at $10 a ton (R30) or over, come under the Fertiliser Control Act. In some only farmyard manure, lime ashes, gypsum and salt are excluded. Two specially mention cotton seed-meal as being excluded, but the digest of the laws I consulted leaves some doubt whether this is a total exemption or only an exemption from the payment of fees.

The committee referred to above gives the following as the first resolution passed by them:—

"All substances containing nitrogen, potash, or phosphoric acid, sold, offered or exposed for sale for manurial purposes, excepting the dung of domestic animals when sold as such, should be subject to inspection."

In regard to the fees charged for this fertiliser control work, considerable difference exists in the various states. In many the labels required to be attached to each parcel of fertiliser, giving the composition of that fertiliser and other information required by law, are sold by the inspector. The price of the labels required for one ton of fertiliser differs in the different states from 15 cents (7½ annas) to 50 cents (R1-9*as*). In other states a fee varying from $2 (R6) to $10 (R30) is charged for the analysis of each constituent of plant food determined. In still others the licence to sell a particular brand of fertiliser is sold. The price charged varies from $1 (R3) to $100 (R300). In many of the states a combination of two of these methods is used. This accounts for the great variation in the scale of fees charged. In all cases it is intended that the fees charged to the manufacturer shall very nearly cover the expenses incurred and in some cases a provision is made for the disposal of profits from the work.

DR. A. LEHMANN, PH.D.
Agricultural Chemist to the Government of Mysore

APPENDIX E.

PROGRAMME FOR THE SECOND MEETING OF THE BOARD OF AGRICULTURE.

SUBJECT I.—*The confirmation of the Proceedings of the last meeting.*

A note is attached showing the action taken on the recommendations of the Board. (See Appendix I.)

SUBJECT II.—*The Programme of work of the Imperial Department of Agriculture.*

A consideration of the programmes submitted by—

(*a*) The Director, Pusa Research Station;
(*b*) The Agricultural Chemist;
(*c*) The Cryptogamic Botanist;
(*d*) The Entomologist.

2. Provincial Directors should examine them to see whether they meet the requirements of their Provinces. Imperial experts should examine them to see whether the programmes of branches, other than their own, meet their requirements.

SUBJECT III.—*The Programmes of work of the Provincial Departments of Agriculture.*

A consideration of the programmes submitted by—

(*a*) Bombay,
(*b*) United Provinces,
(*c*) Bengal,
(*d*) Madras,
(*e*) Punjab,
(*f*) Burma,
(*g*) Central Provinces,
(*h*) Eastern Bengal and Assam,
(*i*) Mysore State.

2. The Imperial Experts should consider whether the programmes meet their requirements, and whether they can suggest improvements. The Provincial Directors should consider whether the programmes of other Provinces can be improved so as to meet any special requirement of their province or to co-ordinate the work.

SUBJECT IV.—*The Improvement of Indian Wheats.*

A consideration of the notes submitted by the Provincial departments, and a discussion as to the best lines for future experimental work and the definitive objects.

SUBJECT V.—*The Improvement of Indian Tobacco.*

A consideration of the notes submitted by Provincial departments, and a similar discussion to settle the best lines for future work.

SUBJECT VI.—*Agricultural Education.*

A consideration of the curriculum of studies best suited for Provincial agricultural colleges and schools. A subsidiary matter is the designation or titles which should be allotted to the passed students.

SUBJECT VII.—*Veterinary.*

The following, amongst other matters, will be discussed:—

(*a*) the curtailment of grazing grounds;
(*b*) the best methods of utilizing the services of Veterinary Assistants *i.e.*, by stationary work in dispensaries or by itinerating work in villages;
(*c*) the provision of fodder in times of famines.

SUBJECT VIII.—*The use of Commercial Fertilisers in India.*

A discussion of the possibility of extending the use of artificial manures and of the advisability of any action to secure their supply with a guarantee of purity.

F. G. SLY,
Offg. Inspector General of Agriculture in India.

APPENDIX F.

PROGRAMME OF THE IMPERIAL DEPARTMENT OF AGRICULTURE.

PROGRAMME OF THE AGRICULTURAL RESEARCH INSTITUTE, PUSA, FOR 1906.

In submitting to the Board the programme of work for the coming year I have to remark that at last year's conference members were invited to forward suggestions on the work to be carried on at Pusa The Departments of Agriculture in Assam, Madras, Central Provinces, Bombay and Bengal have sent in their recommendations, as well as Capt. Gage, Superintendent of the Royal Botanical Gardens, Calcutta, Professor Gammie, Economic Botanist, Bombay, Dr. Lehmann, Agricultural Chemist to the Government of Mysore, and Dr. Harold Mann, Scientific Officer to the Indian Tea Association. While we welcome the numerous suggestions that have been received, it is quite impossible to incorporate anything but a fraction of them in the coming year's programme. Special notice, however, should be taken of the recommendations of Drs. Mann and Lehmann on the question of permanent experiments. Their proposals are in effect that the investigations at Pusa should not be of a local nor of a varietal nature; but possess a more far reaching character, for the purpose of solving general problems of Indian agriculture, applicable to the whole of India, and which are too difficult or too general to be undertaken by any provincial farm. I may say that such a proposition has not only the cordial approval of the Pusa staff, but they had already anticipated such a line of action to a certain extent, as is evidenced by the work already in hand. It is manifest that Pusa being an all-India Institution, should take up as its primary work fundamental problems of the nature indicated. But while accepting these general principles, the determination of the exact work to be undertaken, and the most appropriate time to start it, requires consideration. Collaboration among the various branches will be necessary, and a very considerable amount of preliminary preparation will have to be got through. I wish strongly to impress the Board with the fact that we are still in the throes of this preliminary work, and it would be both unfair to the staff, as well as perhaps courting disaster, if we entered on work for which we were not prepared. Certain it is that we are not ready to commence field experiments to determine the nutrient requirements of Indian crops, as suggested by Dr. Mann. I explained last year that work on the farm had been mostly the clearing of jungle and the breaking up of grass land. Since then we have been chiefly concerned in bringing this land into a normal state of cultivation. Some portions have fairly responded to our efforts, but when I say that we have not as yet been able to apply a single cart load of cattle manure on the land, simply because we have not got it accumulated in a sufficiently decomposed state, it will be understood how far we are from the point of normality required. It will doubtless be admitted that where fields are required in normal condition, it will be useless to attempt to carry out experiments on land which had been only one or two years under crops and never manured. Secondly, our buildings, fittings and apparatus are not ready, and though we are doing our best by the use of temporary buildings to carry on a limited number of investigations, satisfactory research of a high order cannot be accomplished until these necessary requirements are supplied. Thirdly, the staff have only recently taken up their residence and it is not complete yet. Time must be given to them to settle down and prepare themselves. The result is that while we are in full accord with the general principles laid down in the recommendations of Drs. Mann and Lehmann, we are not prepared at present to include any definite investigation of a classic type in this year's programme. I should, however, mention that in the work already commenced by the Agricultural Chemist on the availability of plant food in Indian soils, the diffusion of salts and behaviour of water, the biological as well as the systematic work of the Entomologist and Mycologist, and some of the investigations of the Economic Botanist, we have examples of work of a fundamental nature useful to the whole of India. On the question of teaching I have to remark that as the college and hostel are not ready we cannot at present accommodate students. In order, however, to supply a much felt want

in the provinces for trained men, we are taking in a limited number of probationers in each branch for short courses of training.

B. COVENTRY,
Director of the Agricultural Research Institute, and Principal of the Agricultural College, Pusa.

I.—Agricultural Chemistry.

1. *Soils.*—The determination of the *availability of plant food*, more especially of phosphates, in soils, which was referred to in the last programme, will be continued.

2. In relation to the *diffusion of soluble salts*, such as nitrates, through soils, there is very little information available. It is known, for example, that nitrates are formed chiefly in the upper soil, but to what extent this salt moves to other strata independently of any movement of water, is very imperfectly known. A preliminary set of tests has been made at Dehra, and it is proposed to continue these at Pusa.

3. *Water in soil.*—Drain-gauges, similar to those at Rothamsted and Cawnpore, are to be constructed at Pusa, and the records of the amount of percolation from these will add much to the very imperfect knowledge which we possess at present regarding soil moisture under Indian conditions. In addition to the percolation, a record will be maintained of the amount of water in the soil throughout the year. Determinations on this point made at Cawnpore in June last, indicated that the loss of moisture during the hot weather is not so great as is generally supposed.

4. A record will be maintained during the year of the amount of ammonia and nitrate in the rain water, in the dew and in the percolation water. Regarding the first named, it is improbable that the quantities will differ materially from what has been met with elsewhere, and the only object of keeping this record is for the instruction of the probationers who are attached to this office. As to the composition of dew there is rather more novelty. The subject of the quantity of nitrate which passes away with percolation water is naturally most important, as it may become a considerable item under certain conditions.

5. *Manures.*—Of work on the subject of manures, it is intended to put the new substance calcium cyanamide to as complete a test as possible, though the quantity of cyanamide at hand is only small.

6. *Sugarcane.*—The usefulness of analysing the juice of sugarcane in the field was again demonstrated last cold weather, whereby some cane of very high quality was found in the Balaghat District of the Central Provinces. It is proposed to extend these operations, though the details of the work are not settled at the time of writing. It is probable that two assistants will be deputed to the work during January and February.

7. *Cyanogenesis in plants.*—The cause of the presence of hydrocyanic acid in some plants is now known to be the hydrolysis of a glucoside, but the conditions under which the quantity of glucoside varies in the plant are unknown. Some experiments will be undertaken during the year with a view to determine these conditions. The plants to be experimented with will be *Andropogon sorghum* (Juar) and *Manihot utilissima* (Tapioca root).

8. *Food-grains and oil-seeds.*—In relation to food-grains and oil-seeds, attention is now being paid more especially to the analyses of the ash and the determination of the starch in some of them.

9. In addition to the foregoing a large number of specimens is examined yearly for Provincial Agricultural Departments.

10. Four probationers from Provincial Departments will be entertained.

J. W. LEATHER, PH. D.,
Agricultural Chemist to the Government of India.

II.—Economic Botany.

1. *Teaching and training.*—Limited to the Assistants.

2. *Research work and Investigations.*—Improvement of Indian wheats, cotton, and indigo. Investigation on the preservation of the vitality of seeds.

3. *Experimental work and demonstrations.*—Permanent experiments on the treatment of Indian fruits (citrus plants, plums, pears, loquats, peaches, custard apples, guavas, litchis, mangoes, grapes, figs and plantains).

4. *General.*—The completion of the Botanical Garden, including permanent fruit experiments, varieties of Indian and other fruits, trial ground, ornamental portion and a collection of economic plants arranged according to products.

A. HOWARD, M.A.,
Biological Botanist,
Agricultural Research Institute, Pusa.

III.—Mycology.

1. *Teaching and Training.*—Two apprentices have recently joined my office from Bengal and the Central Provinces respectively, for a training in Mycology intended to fit them for assistants' posts under the Mycologist whom it is proposed to appoint to these provinces. A third is expected from the United Provinces. Applications for admission have been received from other provinces, but owing to the limited space at my disposal and the fact that an assistant and two or three fieldmen of my office will have to be trained at the same time, it has been found impossible to accept more than three apprentices for the coming year. It is anticipated that these men will be kept for about eighteen months, the exact period depending to some extent on the ability and previous training of the individual.

2. *Research and experimental work.* (*a*) *Soil fungi in their relation to plant life.*—The study of the fungi of the soil will be continued. This research is intended to be directed along two lines. First the investigation of the symbiotic relation between certain fungi and the roots of a number of higher plants. In this some progress has already been made. Second, the part played by fungi in the decomposition of organic matter in the soil. The experimental work will be carried out in part in the pot-culture house at Pusa.

(*b*) *Wilt producing fungi.*—The cause of the irregular results obtained in inoculations with the *Arhar* wilt fungus will be investigated. Also the study of other wilt diseases will be continued if material be available.

(*c*) *The algal parasite producing "red rust."*—The appearance of this alga as a cause of serious disease of mangoes at Maldah (Bengal), in addition to its already known attacks on tea, indicates the need of further work to clear up some obscure points in its life history and mode of action. This will be taken up.

(*d*) *Sugar-cane diseases.*—Work will be continued on these.

(*e*) *Cereal and flax rusts.*—Work on the former will be continued on the lines described in last year's programme, as several provincial farms have already made arrangements for the testing of the resistance of wheat varieties to the different rusts. The latter will be taken up this year.

(*f*) *Seed treatment with formaline against certain diseases.*—This gave excellent results with oat smut last year, and will be tried again for groundnut leaf disease and jowar smuts, as sufficiently affected crops of these were not available last year.

(*g*) A number of other diseases of crops are under study and fresh ones are constantly being reported. The working out of these will occupy a considerable proportion of the Cryptogamic Botanist's time.

3. *Systematic work.* The survey of the Indian fungi will be prosecuted as other work permits. The number of fungi whose identity is known is still a very small proportion of the species which occur, and difficulties of identification due to the want of a sufficient number of named specimens are considerable.

E. J. BUTLER, M. B.,
Cryptogamic Botanist to the Government of India.

IV.—Entomology.

1. It is proposed to make the principal work of the year co-operation with the Provincial Departments of Agriculture in the trial of remedies for injurious insects upon experimental farms. Some progress has been made in this branch

during the past year, and further progress is rendered possible by the publication in a simple form of information about common pests. The results obtained during the past seasons can now be extended to experimental farms, with the assistance of the trained assistants in the Provincial Departments of Agriculture, whose work can now be turned to more practical advantage.

2. The treatment of insect pests infesting the crops grown at Pusa will be continued; the following may be expected to occur, and will be checked on the lines of the treatment successfully adopted during the past season:—Bollworms in cotton, the red cotton bug, the cotton leaf roller, cotton aphis, cotton budworm, cotton looper; mothborer and other borers in cane; termites in cane, groundnut and other crops; the rice bug in rice, *sama* and other small millets; the rice stem borer, wheat aphis, leaf roller of tuer (*Caj-indicus*), tuer aphis, tuer pod fly, tuer pod caterpillar, gram caterpillars, ground grasshoppers and leaf caterpillars in tobacco, hairy caterpillars in san (*Crotolaria juncia*), sunflower, groundnut, cotton, jute, til (*Sesamum indicum*), etc.; sawfly grubs in mustard, toria, etc., the mustard aphis, the diamond back moth in mustard, toria, etc., swarming caterpillars in lucerne, the til leaf caterpillar, the til sphinx, stem borers in brinjal, the maize and juar leaf roller.

In most cases the simplest method is adopted, one which is within the reach of the cultivator; in rare cases, spraying or some similar method has to be adopted. The few pests that have not been successfully checked will be specially studied, and it may be expected that insects will be destructive which did not appear during the past season. The requirements for this inquiry consist of areas of as large a variety of crop plants as possible, grown under normal conditions. The value of juar (*Andropogon sorghum*) and maize as a trap for cane pests and of bhindi (hemp) as a trap for cotton pests will be again studied.

3. The work of the insectary will be continued; the question of the relation of climatic changes to the life histories of insects is an important one and the work of previous seasons will be continued. Methods of increasing the beneficial action of parasitic insects will be studied if time permits, and experiments in testing the action on insects of substances innocuous to cattle will be commenced. New pests not hitherto studied will be reared in the insectary and the usual work—rearing large numbers of each common pest—will be continued.

4. Special attention has been directed to the insects which by biting man and cattle disseminate diseases. This enquiry will be continued, the number, habits and distribution of biting flies in India being the subject of enquiry with a view to providing information for the medical and sanitary authorities engaged in investigating fly-borne diseases.

5. The insect survey of India will be continued, and it is hoped that progress will be made in the identification of insects. Specimens of injurious insects are being prepared for distribution in a form suitable for permanent preservation.

H. MAXWELL-LEFROY, M.A.,
Entomologist to the Government of India.

V.—Agricultural Bacteriology.

As this officer will be on deputation during the coming year no programme is submitted.

VI.—Agriculture.

1. *Teaching and Training.*—The training of the probationers and fieldmen at present on the farm, namely, two from Bengal, two from Assam and one from Central Provinces.

2. *Experiment work.*—(i) Comparative tests as to yield and feeding value of some of the more common fodders, such as juar (*Andropogon sorghum*), maize, and lucerne grown (*a*) under irrigation, (*b*) on natural moisture.

(ii) Experiments in cultivation of sugarcane, chiefly as regards depth of cultivation; an attempt will also be made to ascertain how far deep cultivation can advantageously be effected by bullock power.

3. *General.*—This will include improvement of the pastures and of the farm generally, as well as supervision of the breeding herds.

E. SHEARER, M. A.,
Agri-Horticulturist, Agricultural Research Institute, Pusa.

APPENDIX G

PROGRAMMES OF PROVINCIAL DEPARTMENTS OF AGRICULTURE.

BOMBAY.

Extract paragraphs 2—4 of letter No. A-9024, dated the 11th December 1905, from H. S. LAWRENCE, Esq., I.C.S., Director of Agriculture, Bombay Presidency, Poona, to the Inspector-General of Agriculture in India.

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2. In regard to the programme of work of the ensuing year I forward 50 copies of the last * Annual Report of our Experimental Farms. Fifty copies of the * Administration Report of the Department will follow shortly. No special departure is likely to be undertaken from the lines of work already in progress.

3. In regard to Agricultural education I have the honour to observe that the curriculum of the studies is prescribed by the Bombay University and a revised curriculum has been recently submitted by this Department to the University for consideration, of which 50 printed copies are attached.

4. I have the honour to suggest that the subject of fertilisers may be added to the programme for discussion. I should be glad to obtain information from your scientific advisers regarding the possible utilization of mineral fertilisers in this country and regarding the sources of supply whether indigenous or foreign.

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* Not printed in these proceedings.

UNITED PROVINCES.

The following programme follows the order of subjects in the programme submitted last year :—

1. The *continuous investigations* (field and laboratory) need not be detailed.

2. *Study of individual crops* continues.—The crops now under study are juar (*Andropogon sorghum*), poppy, wheat, and cotton: in each case the varieties grown in the province are being worked out, and their merits and defects determined.

3. *Improvements in cropping.*—The system of distributing seed continues; it is being extended in South Oudh through seed societies founded by the Registrar of Co-operative Credit Societies.

Experiments on cotton with artificial manures are being conducted as desired by the Inspector-General of Agriculture.

Selection of cotton seed is being carried out as recommended by the Board of Agriculture; hybridization of cotton is also being attempted.

4. The *search for varieties of crops* for particular localities continues: we are looking for (*a*) a rice for the canal tracts in Bundelkhand; (*b*) a wheat for Bundelkhand; (*c*) better cotton for the duab; (*d*) early-maturing kharif food crops for Bundelkhand and for South Oudh.

5. The *application of water to land* is being studied at Cawnpore, the details of the investigation having been worked out

6. The attempt to destroy *kans*-grass (*Saccharum spontaneum*) in Bundelkhand continues, but the lines of the experiment have been revised.

7. The study of the *agricultural entomology* of the provinces continues in Mr. Hayman's hands.

8. The *investigation of wheat rust* is being continued by Mr. Hayman in conjunction with Dr. Butler.

9. The experiments with the barren clays (known as *usar*) continue, but it has not been found possible to add to their scope.

10. The whole subject of *well-sinking* is engaging special attention under an officer deputed for that purpose. The special points under investigation are the construction of percolation wells, and the simplification of boring tools; and a bulletin is under preparation which will serve as a practical guide to constructors.

A well-survey is in operation throughout the provinces, the object of which is gradually to locate every village where difficulties in well sinking exist; and a staff is being organised to study each locality in turn.

The improvement of the *tarai* drinking water mentioned in last year's programme has now passed from the Department to the engineering staff of the estate; wherever the methods recommended have been followed, a supply of water potable by European standards has been secured, and a programme has been adopted under which every village under the control of Government in this tract will get its supply within a few years.

11. The demonstration of improvements on the indigenous *methods of making raw-sugar* are again being continued and are winning favour. The study of native methods of refining continues.

12. In Bundelkhand it has been found unnecessary to *rear breeding-bulls*, as good animals can be purchased ready for breeding. The scheme for providing bulls in the northern breeding tract is in the hands of the Civil Veterinary Department.

13. Experiments in *soil-inoculation* have been started as desired by the Inspector General of Agriculture.

14. It may be added that the programme will probably be extended before the Board meets. For the last few months the officers of the Department have been engaged mainly in its re-organisation on a larger scale and particularly in recruiting and training the subordinate staff, so that there has not been time to fix definitely or in detail the extended programme of operations.

Bengal.

Agricultural Experiments, Investigations and Improvements to be carried out in Bengal in 1906-07.

No.	Name of crop.	Nature of experiment	Where to be continued or attempted.	Remarks.
1	Paddy . . .	Variety experiment (generally fine or scented varieties with a common or coarse local variety as a standard of comparison).	To be continued at Burdwan, Dumraon, Cuttack.	Six or so different varieties will be compared with the local variety. One variety of Japanese paddy and Central Provinces fine Aus are being tested.
2	„ . . .	Manure experiment (comparison of cow-dung, oil-cakes bone-meal, or nitro, by itself or in mixture with each other. Also green manuring with cow-peas, san-hemp, dhaincha, etc.)	Burdwan, Dumraon, Cuttack.	
3	„ . . .	Methods of cultivation	Burdwan, Cuttack .	6"—9" and 12" apart are being tried.
		(a) Spacing experiment in transplantation of seedlings		
4	„ . . .	(b) Number of seedlings per hole in transplantation.	Burdwan, Cuttack .	1, 2, 4, and 8 per clump are being tried.
5	„ . . .	Rotation experiments with Aman paddy.	Burdwan, Cuttack .	Aman paddy after jute, as compared with Aman paddy alone.
6	„ . . .	Irrigation experiments.		
		Economy of water in irrigation.	Burdwan, Dumraon, Cuttack.	2", 4" and 6" are being tested.
7	„ . . .	*Nigarh* versus no *nigarh*	Dumraon, Ramnagar (Ryot's field)	*Nigarh* is the practice in vogue in South Bihar of draining the paddy fields from about 10th to 25th September. This accentuates the need for water immediately afterwards. The experiment is meant to see if *nigarh* may be dispensed with.
8	Wheat . . .	Variety experiment .	Dumraon, Cuttack, Sripur.	
9	„ . . .	Manure experiment .	Dumraon, Sripur. .	Little wheat is grown in Bengal proper or Orissa, so outside Bihar an attempt will be made to introduce the best variety. The question of the best way of manuring is not so important in those parts.

Agricultural Experiments, Investigations and Improvements to be carried out in Bengal in 1906-07—continued.

No	Name of crop.	Nature of experiment.	Where to be continued or attempted.	Remarks.
10	Wheat . .	Method of cultivation:—deep and shallow ploughing (new experiment).	Dumraon, Sripur.	
11	„ . . .	Prevention of smut .	Do. . .	Pickling seed with ½ per cent solution of copper sulphate.
12	Oats . . .	Varieties . . .	Dumraon, Cuttack, Sripur.	
13	Jute . . .	Do. . .	Burdwan, Cuttack .	Several varieties are being tried at Burdwan.
14	„ . . .	Manure experiments .	Burdwan . . .	Cow-dung, castor cake, bone-meal, salt petre.
15	„ . . .	Spacing experiment .	Do, . . .	4", 6", 8", and 10" are being tried.
16	„ . . .	Harvesting at different stages of growth.	Do.	
17	„ . . .	Drill versus broadcast .	Do. . . .	Plants are grown to produce strong bushy plants in contradistinction to the tall one-stemmed plant for fibre.
18	„ . . .	Seed selection . .	At several centres.	
19	Cotton . . .	Variety experiment .	Sripur, Dumraon, Cuttack.	Egyptian, American, Dharwar, American Sea Island, Broach, etc, also tree cotton and local varieties.
20	„ . . .	Selection of the seed of the indigenous varieties.	Saran, Muzaffarpur, Darbhanga, Manbhum and Cuttack.	Seed is selected from the most prolific plants in these districts. The selected seed will be distributed among the ryots of the respective districts.
21	Sugarcane . .	Variety experiment .	Burdwan, Dumraon, Cuttack.	Some six varieties. So far the Khari variety has given the best results. It is not so badly attacked by white-ants and jackals as the other varieties.
22	„ . . .	Manure experiment (as in the case of paddy, see No 2 above.)	Do.	
23	„ . . .	Methods of cultivation.	Do.	Three methods are being tested—Poona Bed system, Bihar Planters' system of trenches, and the local system of planting in the plough furrows.
24	Potatoes . . .	Variety experiments.	Do.	Naini Tal, Patna, Bettiah, Farakkabad, will be compared. The local varieties in Bengal are generally worthless.
25	„ . . .	Manure (cow-dung, oil-cakes, bonemeal, saltpetre, etc.).	Do.	
26	Maize . . .	Variety experiment .	Sripur, Dumraon, Cuttack.	Kalimpong and Jaunpur varieties will be compared with the local variety.
27	Jowar . . .	(a) Variety experiment (including fodder varieties).	Sripur and Dumraon.	
		(b) Drilling versus broad-casting.		
28	Mustard . . .	Variety experiment .	Dumraon.	
29	Castor . . .	Do. . . .	Sripur, Dumraon.	
30	Rhea . . .	.....	Sripur	The chief question for experiment is that of a cheap method of extracting the fibre, i.e., a cheap machine.
31	Fodder . . .	Varieties . . .	Cuttack and Sripur.	
32	„ . . .	Ensilage . . .	Sripur.	
33	Seed selection generally.	.....	All Farms . . .	All the Farm Superintendents and Overseers are selecting seed from the most prolific and vigorous plants of every crop they grow for distribution.
34	Mixed crops as compared with single crops.	.. ...	Sripur and Dumraon .	*E g.*, gram and linseed, wheat and peas, castor, rahar, maize, cotton and castor and cotton and arhar.
35	Rotation experiments	.....	Cuttack, Sripur . .	Local methods will be tested against a regular rotation. This will be continued for several years.

Agricultural Experiments, Investigations and Improvements to be carried out in Bengal in 1906-07—concluded.

No	Name of crop.	Nature of experiment.	Where to be continued or attempted.	Remarks.
36	Indigo . . .	.....	.....	Improvement in manufacture, analysis of indigotin, research regarding colouring matter in the plant, etc, at Sirsia, Muzaffarpur.
37	Irrigation . . .	.....	.....	Crop-cutting experiments conducted by officers of the Agricultural Department and Public Works Department on irrigated and unirrigated areas
38	Leguminosæ Inoculation.	Seed and Soil Inoculation.	Cuttack, Burdwan and Sripur.	Dr. Moore's (U. S. A.) and Dr. Holtner's (Germany) cultures will be tried on poor sandy soils with Leguminosæ for green manuring purposes.
39	Veterinary Department.	.....	Sripur and Pusa . .	Cattle-breeding at Sripur (and Pusa. Improvement of local draught, and milch cattle Extension of the Belgachia College Development of the subordinate veterinary service.
40	Fairs and exhibitions	.....	.....	Demonstrations by Travelling Overseers of agricultural products, implements, etc.
41	Silk and Tussar .	.....	.....	Microscopical examination of seed enquiries as to decline of the industries, seed nurseries.
42	Another farm to be acquired and set out for experimental work.	.....	.....	.....

C. A. OLDHAM,
Director of Agriculture, Bengal.

16th November 1905.

Proceedings of the Board of Revenue, Madras (Revenue Settlement, Land Records and Agriculture), No. 6857-Mis., dated the 20th November 1905.

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RESOLUTION.

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2. The Board invites the attention of the Inspector-General of Agriculture to the fact that the time of the year at present fixed for these meetings is most inconvenient so far as this Province is concerned, January being the month in which the farms in the Madras Presidency require the particular attention of the supervising officers, while the meetings of the Legislative Council which are held in that month preclude the Director of Agriculture from attending the Conference. It would therefore suit Madras if arrangements could, without inconvenience to the Agricultural officers of other Provinces, be made to hold future meetings of the Board of Agriculture at Pusa in October—November.

3. The Board has no additions to suggest to the programme sketched in paragraph 2 of the Inspector-General's letter quoted above.

4. With reference to paragraph 5 of the same letter, the Inspector-General will be furnished with (1) a note containing the programme of the work to be done in the ensuing year by the Provincial Agricultural Department, (2) a note on wheat in the Madras Presidency, (3) a note on tobacco and (4) memoranda by the Deputy Director and the Government Botanist respectively containing their views on the curriculum of studies for the Provincial Agricultural College. The Board takes this opportunity to point out to the Inspector-General that it is extremely difficult for busy officers to prepare and furnish a complete account of any crop at such short notice as that given in his letters under reply in regard to Indian wheat and tobacco. Thus Mr. Benson writes:—"The earlier work in India on tobacco was compiled some

30 years ago by Mr. O'Connor and there is much on the subject in the Dictionary of Economic Products. These I have not had time to refer to." The Board would therefore suggest that the particular crop or crops to be discussed at the meeting of the Board of Agriculture in any coming year should be settled by them at the previous year's Conference, so that the greater part of a year might be available for making enquiries and collating information in the matter.

Section I.—Investigations.

(i) *Systematic Botanical Survey.*—(*a*) The Government Botanist will study the flora of typical sandal-wood tracts, the flora of the Taliparamba farm and the wild peppers of South India, name the forest trees of the Mysore coffee zone and collect lemon and other grasses and such plants of interest as may be met with in his agricultural tours.

(*b*) The study of the haustoria (root parasites) of the sandal trees, *Olax scandens* and *Cansjera Rheedii*, will be continued and attention devoted to the root parasites of pastures which occasionally ravage sugarcane (*Saccharum officinarum*), paddy (*Oryza sativa*) and cholam (*Andropogon sorghum*) fields.

(*c*) The large collections of Loranthaceæ, which are ravaging forest trees, will be added to.

(ii) *Economic Survey.*—(*a*) The economic survey of the Presidency pure and simple will also be proceeded with.

(*b*) A field investigation of agaves, cottons, indigos, etc., will be made if possible, and the study of the pepper plantations in the Wynaad, which has already yielded certain interesting results, will be continued.

(iii) *Studies in practical agriculture.*—The Assistants recently sanctioned for the various farms will on their entertainment be largely employed in touring during the chief growing season, and studies in practical agriculture will be largely developed.

(iv) The work of investigation of diseases in plants of economic importance will receive an impetus owing to the additions recently made to the Government Botanist's staff, and the regular survey of plant diseases will be attempted.

Section II.—Experiments and Improvements.

(i) *In respect of particular agricultural practices.*—(*a*) Experiments designed to test the value of deeper tillage as a remedy for the evil effects of drought will be continued at the Bellary Farm and revived at Koilpatti.

(*b*) Experiments in the determination of the comparative value of the various methods of collecting and utilising cattle excreta, including urine, will be continued at both the farms.

(*c*) As suggested by the Inspector-General, two series of experiments in manuring cotton have been started at the Bellary and Koilpatti Farms, one with continuous cotton and the other with cotton in rotation, and the latter experiments are conducted on comparative plots adjoining those utilized for the cattle manure experiments mentioned above: these will be continued.

(*d*) Two bulls of the Nellore type will be provided at the Samalkota Farm and utilised for the farm work and for the improvement of indigenous cattle, with the object of disabusing ryots of the impression that breeding bulls cannot be used for field work. Selected bulls will also be provided at the Taliparamba pepper farm in the Malabar district, where the local breed is capable of much improvement.

(ii) *In respect of particular crops or classes of crops or soil.*—(*a*) *Cotton.*—At the Bellary and Koilpatti Farms, the study of the local varieties of cotton (Westerns and Tinnies) will be continued on the same lines as in previous years and steps taken to improve the quality and outturn of the specially valued sorts by selection and, to a very limited degree, by cross-breeding. An exotic called the Cambodia cotton, which gave promise of being valuable on black cotton soil, will be further tried at the Koilpatti Farm; and if Government sanction the extension of the area of the farm, seed will be produced in large quantities for wide distribution to ryots in the Tinnevelly

district. At the Taliparamba farm, experiments will be made in the growth of long-stapled cottons for which the climate seems to be well suited. In the event of Government sanctioning the establishment of a farm in the tract where the cotton known as "Northerns" is grown, attempts will be made to produce pure seed and to improve the staple by selection and crossing. With a view to improve the quality and outturn of the cotton grown throughout the Presidency generally, good cotton seed of the best local sorts will be collected and distributed to royts for cultivation.

(*b*) Experiments in seed selection will be continued at the Bellary Farm in the case of sorghum (*Andropogon sorghum*), specially the local white varieties, and the comparative study of a number of local sorts and of nine Bombay varieties of fodder sorghums at that farm and of three Bombay varieties and of one local variety of cumbu (*Pennisetum typhoideum*) at Koilpatti will be continued. Trials of the local fodder sorghums will also be made at the latter place.

(*c*) *Sugarcane* (*Saccharum officinarum*).—The work at the Samalkota Farm will be continued on the lines indicated in the programme for 1905-06. The farm land which is being permanently acquired will be laid out and the necessary buildings erected. Forty-five varieties of sugarcane, both indigenous and imported, are now grown at the farm. As the red Mauritius and the striped Mauritius seedlings which were distributed at the close of 1904-05 were eagerly competed for, and as it has been found by experience that *no* cane can long remain immune from the disease, if dealt with by ryots in the customary local manner, the question of extending the nursery area so as to enable the farm to fulfil its function of a seed-depôt for the district will engage attention. The various experiments made at the farm which promise success will be continued, and among them may be mentioned the modification of the local practice of tying the canes to bamboos which entails great expense, the introduction of a cheaper form of oil-cake for manuring, the extension of stool-planting, the introduction in the interests of the ryots of the Kistna delta, of the "gouda maushi" system of nurseries whereby the actual field growth of the canes can be reduced to 9 months, and the conduct, on an improved basis, of ripening tests under which the character of the juice will be determined at fortnightly intervals in the chief varieties in plants under different manures and under different conditions of cultivation.

(*d*) The cultivation of the two varieties of jute, namely, *Corchorus olitorius*, and *Corchorus capsularis*, already grown on the farm at the instance of the Inspector-General, will be continued.

(*e*) *Groundnut* (*Arachis hypogœa*).—At the temporary farm opened at Palur in the South Arcot district to improve the groundnut industry, seeds of a large number of varieties, which are expected from Japan, the United States of America, West Africa and Mauritius, will be cultivated and the growth of the new Mauritius seed compared with that of the seed already introduced into the district 8 or 10 years ago. A set of drills and other agricultural implements imported from Guntur will be tried in the local agriculture, and with a view to remedy the lack of manure which is the chief agricultural defect of the district, the practice of opening grass and weed pits has been introduced as at Samalkota, and will be continued, and some preliminary manurial experiments made with chemical fertilisers. The farm will continue to be used as a nursery for the distribution of immune varieties of the sugar-canes grown at Samalkota among the ryots of the Southern districts of the Presidency. Various indigos obtained from Bengal, Travancore and other places will continue to be grown as a rotation crop, and samples of the local indigo prepared by the dry and wet leaf processes will be submitted for analysis with the object of obtaining some definite idea as to the alleged inferiority of the local product to that of Bengal.

(*f*) *Pepper* (*Piper nigrum*).—With the object of checking the deterioration of the pepper industry and producing disease-resisting varieties, a farm has been established at Taliparamba in the Malabar district. The experiments at the farm will be principally concerned with the trial of various standards for pepper, the growth of pepper on railings after the manner of the Chinese in Singapore, the treatment of the plots with various kinds of green-dressing, such as *Cassia Tora*, groundnut and sun-hemp, the introduction of leaf-mould pits as is done in the North Canara gardens, the thinning or filling of top and

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and any others that may specially be recommended by the Imperial Agricultural Chemist. As the result of a careful investigation of the cultivated and wild varieties, it has been found that the difference between them lies in the hermaphroditism of the cultivated flowers and the unisexuality of the wild forms. Definite experiments will be commenced by the use of tents and test tubes for determining the extent to which the peppers are self-fertilising; the study of this matter will be necessary for the conduct of experiments in cross-fertilising and the raising of new strains. Certain selected vines will be marked in the Wynaad; seed of these and cuttings will be acquired for the farm and a regular stream of fresh blood will be introduced into the plantations on the plains.

(*g*) A pumping station will be established on the banks of the Hagari for the conduct of experiments, with a view to determine the best way of utilising water on black cotton land cultivated chiefly with paddy and cotton as well as the duty of water on such lands.

(*h*) A Central farm is being established at Coimbatore for the conduct of comparative experiments and researches by the staff of the new Technical School of Agriculture to be opened there as well as the other experts of the Agricultural Department; and it will, during 1906-07, be laid out and cropped in order to ascertain the relative qualities of the soil in the different plots.

(*i*) The land attached to the pumping station at Attur in the Chingleput district will be devoted to the growth of perennial cottons (including caravonica), fodder production and fruit growing.

(*j*) *The agave* plantation at Hindupur will be worked as heretofore with a view to determine data as to the intervals of time at which agave leaves can be cut with advantage and the rate of production of agave fibre on the poor dry soils of the high country where it is situated.

(*k*) *Tobacco.*—Pending the entertainment of an Agricultural Chemist and a skilled curer, the rough and ready test now being made in respect of the value of saltpetre on land near Dindigul in the Madura district cultivated with tobacco under wells where the water showed little or no nitrate will be continued. The cultivation of tobacco at Koilpatti will be continued in view mainly to the production of seed, the attempts made in the past to produce a cigar leaf having nearly failed. Experiments in the cultivation of foreign varieties of tobacco on certain *lankas* of the Godavari district will be made by Mr. Barry of Cocanada in consultation with the Deputy Director of Agriculture and with the aid of approved and up-to-date appliances.

(*l*) *Paddy* (*Oryza sativa*).—The trials of two sorts of paddy which are capable of maturing rapidly and suitable for growth under wells in which the water-supply is limited will be continued at Koilpatti, and the experiments already made in the Agricultural College at Saidapet and at Shiyali and Sivigiri in the Tanjore and Tinnevelly districts respectively, with these and other varieties received from the Inspector-General of Agriculture, will be continued.

(*m*) *Paspalum dilatatum.*—This fodder grass having given some promise of value under careful treatment, it will be more fully tested at Koilpatti under ordinary field conditions.

(*n*) The experiments in the reclamation of *Alkaline land* in the village of Therkuteruvu in the Madura district will be continued; and similar experiments will be made under the Deputy Director's advice by ryots holding such lands in certain villages of the Madura and Melur taluqs.

(*o*) *Co-operative experiments.*—Rough and ready tests of improved agricultural practices of a simple nature suggested to the members of the Tanjore Agricultural and Industrial Institution are being carried out and will be continued under the advice of the Deputy Director of Agriculture and an Agricultural Inspector; the Deputy Director will also help the District Boards of Madura and Tanjore with advice in the working of the farms already opened or about to be opened by them.

Section III.—Veterinary Improvements.

(i) Extension of inoculation work in the districts.

(ii) Selection of young bulls of the three principal breeds, namely, Ongole, Kangyam and Alumbadi, and their distribution among villages in the most suitable localities where the several breeds are to be found.

(iii) The opening of additional Veterinary Dispensaries.

(iv) The continuance of Veterinary education and of the encouragement of pony breeding.

PUNJAB.

The current experiments will be continued at the Lyallpur Experimental Farm, attention being mainly directed to wheat and cotton. With wheat, there are variety, manurial, hydraulic, seed-rate and rust experiments. There will be variety, manurial and space-between-rows experiments with both indigenous and acclimatised American cottons. With the latter and with Egyptian cotton, successive sowings will be made to determine the best time of sowing. Selection and hybridization will be carried on with both wheat and cotton. Other minor experiments are in hand with barley, gram, maize, jowar for fodder, jowar (*Andropogon sorghum*), sugarcane, indigo and oil-seeds. The farm is being extended to 300 acres, thus providing 250 acres for seed growing. Seed distribution will be undertaken on a considerable scale this year. The Sargodha Seed Farm of 600 acres is now fully under cultivation. Its object is to supply the colonists in the Jhelum Canal with seed of good local varieties of wheat and cotton. American cotton is also grown on a considerable scale.

2. Outside the farm, progress was made in the summer of 1905 with the extension of American cotton cultivation, some 300 acres being sown. The plants flourished in all plots, but it is unfortunate that an unprecedented visitation of boll-worm resulted in the practically complete failure of all varieties of cotton in the Central Punjab. A small quantity of American cotton, about a 6-anna crop, has, however, been collected at Sargodha. This experiment will be persevered with next year, but with caution, having regard to the possible return of the boll-worm pest.

3. The operations with a view to the selection and distribution of good seed of the best indigenous varieties of cotton were similarly affected. A fresh start will be made in 1906. A report is awaited from the Entomologist to the Government of India, who very kindly visited the affected districts, as to the cause of the abnormal spread of boll-worm. Should any remedial measures be suggested, the Department will endeavour to carry them out. Seed will also have to be imported into the tracts where there was no outturn at all.

4. A new 500-acre farm will be established in the Eastern Punjab.

5. The scheme for the Lyallpur Agricultural College and Research Institute will be developed.

6. A bull-breeding farm will be established at Sargodha. The Veterinary Department is being steadily developed. Preventive inoculation and the supply of suitable bulls in districts are the two most important objects.

BURMA.

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2. I have no addition to suggest to the programme of subjects to be considered at the next meeting of the Board.

With regard to the provincial programme of agricultural work for the coming year, I have the honour to say that Mr. MacKenna's Note on the Programme for 1905 practically holds good for 1906 so far as the general work of the Agricultural Department is concerned. It is proposed to continue the maintenance of the six Experimental gardens mentioned in paragraph 2 of that Note; to continue the distribution of various seeds—English vegetable seeds, Havana tobacco, locally grown wheat seeds to other districts of the province, tea, coffee, American sweet potatoes and ground-nut. Lucerne grass is again

being tried in Mandalay and cotton and Manila hemp in various districts of Upper Burma. Agricultural and live-stock shows will be held at—

(i) Sagu in the Minbu District for the Minbu Division.
(ii) Letpadan in the Tharrawaddy District for the Pegu Division.
(iii) Pyawbwe in the Yamethin District for the Meiktila Division.
(iv) Bhamo for the Bhamo and Myitkyina districts.

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CENTRAL PROVINCES.

Experimental work.

There are at present three experimental farms in the Central Provinces, one at Nagpur, with an *annexe* at Telinkheri, for the cotton and juar country: one at Labandih near Raipur for the rice country, and one at Powarkhera near Hoshangabad for the wheat country. They are now being increased to an area of about 300 acres each: and a new farm is being added for Berar. It is proposed to post three European Superintendents to the administrative charge of work in the cotton, rice and wheat tracts, comprising experimental work at the farms and demonstration work away from head-quarters. The experimental work on which the Department will be engaged during the year will fall under the following heads.

Cotton.

2. A large number of the more promising varieties of cotton both foreign and Indian are being crossed with the object of discovering varieties with lint of good quality and long staple that are sufficiently hardy and productive to commend themselves to local cultivators. The two varieties that predominate locally are the productive but short-stapled *jari* and the long-stapled *bani*, capable of spinning counts up to 40's, but giving a much smaller yield than *jari*. The weak point of Egyptian and American varieties, not excepting even our acclimatised upland Georgian, is that the leaves curl up and turn red in patches towards the end of the rains, and attempts will be made to find a cross that will not do this—a cross of Egyptian and Khaki looks promising at present. Selection of seed from those plants of Upland Georgian which remain strong and healthy throughout will be carried on. The cultivation of *caravonica* and local tree cotton begun this year will be continued.

Wheat.

3. A fairly good rust-resisting wheat has been obtained; but the results of the season, 1904-05, while not conclusive, lead to the belief that species which are rust-resistant in the south of the province are not so in the north; and the experiment will be extended to the northern farm at Powarkhera. Hybridising experiments will also be carried out there.

Fodder crops.

4. Several species of fooder crops, such as Japanese fooder, and various sorghums and drought-resisting grasses, will continue to be tried. It is hoped to make a trial of some of the native Australian grasses which are said to be really drought-resisting and to produce good fooder.

Insect pests and plant diseases.

5. We have at present on the Nagpur Farm two Entomological assistants who are studying the pests that occur on the farm and in its neigbourhood, under the directions of the Government Entomologist. Experiments have been made with insecticides, especially on insects infesting cotton and rice.

Continuous experiments.

6. Various series of experiments will be continued on the effects of different manures, tillage, methods of tillage, and irrigation on wheat and kharif crops.

Rice cultivation.

7. Experimental work is being carried out on the comparison of the different methods of rice cultivation in the Central Provinces, while the cultivation of jute, which has been experimentally undertaken this year, will be continued. The four methods of rice cultivation practised in the Central Provinces are—transplantation; sowing by previous germination; sowing

in situ with subsequent cross-ploughing; and simple sowing *in situ*. An important subject of investigation is whether with the lower rainfall and less efficient protection of Chhattisgarh, the local method of cross-ploughing does not, taking one year with another, give better results than transplantation.

Irrigational experiments.

8. Experiments will be carried out on the Powarkhera and Labhandih farms to discover the duty of water in various classes of soil, the maximum intervals between waterings and other points on which information is required. A pipe line and a metre in the form of a small double concreted tank with a gauge which can be filled from a well or canal and emptied into the field, are being laid down. As no really reliable figures at present exist regarding the duty of water in the Central Provinces, the results of the experiment will be of importance to the Irrigation Department.

Miscellaneous.

9. Double-cropping experiments in the Labhandih farm will be carried out to discover the comparative advantages of broadcasting while the rice is standing, and of drilling in the second crop after the rice is reaped. Rice double-cropped with pulses or linseed is an important crop in the Chhattisgarh and Wainganga Districts.

The eradication of kans (*Saccharum spontaneum*) will be again experimented on. The Batchelor plough, which has a knife-like edge and cuts the kans infested surface into squares by cross ploughing, has so far given the best results. Aloe cultivation will be attempted on light red soil near the Chhattisgarh Farm, with the hope of inducing a European firm to start a fibre-cleaning installation in the neighbourhood. Concessions of land are under offer to such firms for aloe planting.

Experiments will be undertaken to discover the best crop for this light red soil, which is found over laterite, sandstone or limestone rock in considerable areas. A booklet for the use of visitors to the Nagpur Farm is under preparation.

New implements will be purchased and tried from time to time. A type of silo of cylindrical shape made of corrugated iron on a stone foundation will be tried.

Demonstration work.

10. The administration of demonstration work will be carried out on the following lines. The province will be divided for the present into three areas, each under the control of Supervisors in charge of operations in the wheat, rice and cotton tracts. It is hoped that two, if not three, of the European Farm Superintendents alluded to in paragraph 1 will be available by that time: but they will probably be hardly sufficiently conversant with local conditions to exercise the control which will ultimately be required of them. Under each Supervisor will be about seven Agricultural Assistants, trained at the Agricultural College and the Farm, who will each be in charge of a particular demonstration plot or group of plots or will demonstrate the use of some implements or improved method. The question how far the interest and assistance of the District authorities can be elicited by delegating to them some portion of the responsibility for and administrative as opposed to technical control over district demonstration work is under consideration.

Agricultural associations will be kept in close touch with all demonstration work; and meetings of these bodies will be held at experimental or demonstration plots where practicable, this measure having proved a success in the current year.

The particular features of demonstration work that will be attempted during the year will be—

Juar and cotton.

11. The introduction of improved methods of cultivating juar and cotton into Chhattisgarh. The system of sowing cotton and juar by the three-rowed drill has proved its superiority in many districts of the Central Provinces. The special advantage lies in the fact that the bullock hoe can be used for weeding, saving the cost of labour, and giving a superior tilth, the advantages of which to the crop are particularly marked in a wet season. Chhattisgarh has hitherto grown practically no juari at all and a little very inferior cotton. It is hoped to extend the cultivation of these two crops,

and to substitute the improved methods for the broadcast local sowing. The demonstrations have been going on since the year 1899; but a systematic attempt to spread the system was not made till 1902. The result has been to increase cotton cultivation in the area near the Central Provinces cotton mills, but not on the improved lines, and the new methods have not yet caught on much in other places. Drainage of these crops in the heavy soils of Chhattisgarh by shallow open drains about 1′ 6″×9″ has given good results.

Sarson.

12. In upland districts the growing of sarson (*Brassica campestris*) as a second crop after maize in fields close to village sites has been found to give good results, and attempts will be made to spread the practice. Some difficulty has been experienced in obtaining seed.

Rust-proof wheat.

13. The distribution of the seed of this variety to members of District Agricultural Associations will be continued.

Ensilage.

14. It is found that silos do not give good results when made below the ground save in certain special soils. Where wheat-stores built above ground-level are not available for silos, some discrimination has to be exercised in the selection of a site: and more care will be exercised in future in the conduct of these experiments. An increased staff will enable us to make longer preparations.

Saltpetre manure.

15. The distribution of this manure to members of District Agricultural Associations and its application by peripatetic Agricultural Assistants to rice and irrigated wheat will be continued. Care will be taken wherever possible to select two similar plots, one of which will be treated with the saltpetre and the other left untreated; and to compare their results.

Prevention of smut in juar.

16. The practice of pickling juar seed with sulphate of copper has now been recognized as advantageous by a large body of cultivators in the south-west of the province, and matters have progressed beyond the stage of isolated demonstrations by Agricultural Assistants. Revenue Inspectors who have mostly passed through the Agricultural class have been ordered to demonstrate the practice on a large scale.

Irrigation of rice by wells subsidiary to tanks

17. This practice, which was recommended by the Irrigation Commission, has not yet had a fair trial. It will be continued for at any rate another year.

The Meagher system of sewage disposal.

18. This will be continued at one or two selected Municipalities by Agricultural Assistants. Owing to the apathy of Municipal Committees, the exploitation of sewage-fed land has not hitherto made any particular progress save in Nagpur itself.

Demonstrations in irrigation areas.

19. Small plots will be taken up under the larger storage tanks as they come into operation in order to show the cultivators precisely what advantages can be expected from the free use of water. This year free wheat seed and free water are being given at two irrigation areas to a few selected tenants who agree to plough up their rice stubbles and so irrigate wheat. The same practice will be continued; and demonstrations given of the more profitable practices of double-cropping, etc. It is anticipated that the people will be apt to confine their use of the water to protection of their rice crop in a dry year unless their attention is especially directed to the large profits which the free use of water may be expected to bring.

Improved implements.

20. The rise in the wages of agricultural labour is leading the people to consider the desirability of using labour-saving appliances, and applications for winnowers, fodder-cutters, and threshers are increasing in number. In one district the people are making enquiries about reaping machines. It is also believed that a cotton gin of the ordinary type, run at a comparatively low speed by bullock power, will advantage large cultivators or village communities, who can use their own bullocks on this work when they would

otherwise be idle; and can ensure the return of their own seed undamaged and unmixed. Demonstration work will be carried on by Agricultural Assistants and Supervisors with these implements in as many districts as possible. In demonstrating the use of the round-about bullock power machines, it has proved inexpedient to attempt to take them about to too many places, owing to the risk of damage in transit and the difficulty in training local bullocks to the work and in setting up the machine. The fodder cutter that gives the best results is the Harder Ensilage Cutter, costing R135 in Nagpur. A horizontal cut has proved best for juari and cheap horizontal cut machines do not seem to be produced by English firms. Both this and the winnower can be worked by bullock power or by hand.

Sugarcane cultivation and preparation of *gur*.

21. A party is this year to tour through the principal sugarcane tracts, to enquire into the varieties grown and their methods of cultivation, to obtain and forward for analysis specimens of the juice and *gur*, to enquire into the different forms of disease and to demonstrate the improved Poona mill and evaporating pan. This was done in the preceding year, with no particular results proportionate to the expense involved, save that several valuable analyses of *gur* and juice were obtained. The advantages of this mill over the lighter type of iron mill used in Betul are doubtful, as the Poona mill is more costly and takes more bullock power to drive it than the lighter Betul mill; and the main advantage of the Poona pan—economy of fuel—is not conspicuous in a country where fuel is so abundant as in Betul and Balaghat.

It is improbable that this particular demonstration will be resumed another year. It is my own personal opinion that the introduction of these small improvements will have no effect in averting the decline in the growth of sugarcane in the Central Provinces, and the only method that gives any hope of this is to get large contiguous areas grown round a central sugar or *gur*-producing installation. Existing irrigation tanks are about to be largely supplemented by the operations of the Irrigation Department. The sugarcane tract, where the large sugarcane tanks mainly occur, is about to be opened up by a new line of railway, and efforts are being made to induce some large firms to set up a central installation.

Improved cotton seed.

22. In the current year attempts were made to distribute selected cotton seed on a somewhat extensive scale. Large quantities of seed from the best tracts were bought up, both departmentally and through the agency of the mills, and specially ginned; these were sold in various cotton districts. Besides this, agreements were made with certain cultivators that they should grow cotton in selected fields on lines specially calculated to give a good seed yield; the Department guaranteeing them against any loss in doing so. Some difficulty was experienced in keeping the cultivators up to the terms of their agreement; and success was only obtained in a limited number of cases. No opinion can yet be formed regarding the quality of the seed; but if it turns out as well as it is said to look on the successful farms, it will no doubt find a ready sale at high prices, as the Berari is usually ready to pay an enhanced rate for good seed. The experiment will be continued on the same lines next year.

Demonstration work in Feudatory States.

23. I shall endeavour to depute an Agricultural Assistant for a term of years to one or other of the western Chhattisgarh Feudatory States that have taken up cotton-growing for the Central Provinces mills. The influence of the State authorities has been successful in spreading the growth of cotton in the last few years, and it remains to encourage its cultivation on improved lines. The interest of the Feudatory Chiefs in agriculture will, it is hoped, be elicited by the establishment of a demonstration plot under an Agricultural Assistant in connection with the Rajkumar Feudatory Chief's College.

C. E. LOW,

Director of Agriculture, Central Provinces.

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* * * * *

2. The programme of work of my Department includes the following items:—

(1) Re-organisation of the Agricultural Department,
(2) Establishment of a Central Farm, probably near Dacca,
(3) Continuation of investigation into questions concerning jute by the jute expert,
(4) Establishment of an experimental sugarcane plantation at Jorhat,
(5) Sericulture,
(6) Organisation of the experimental farms at Rangpur, Chittagong and Rampur Boalia, and
(7) Continuation of fruit and spice cultivation in the experimental farms in the Khasi and Jaintia Hills,

3. * * * *

4. I regret I am not prepared to offer any opinion at present on the curriculum for agricultural colleges.

PROGRAMME OF EXPERIMENTAL AND DEMONSTRATION WORK AT THE UPPER SHILLONG EXPERIMENTAL FARM AND THE SHILLONG FRUIT GARDEN FOR THE YEAR 1906-1907.

[*N.B.*—These two institutions are managed as one concern.]

1. *Potatoes*—

(*a*) Trial of varieties.
(*b*) Trial of Bordeaux mixture as an insecticide.
(*c*) Trial of manures. It is proposed only to try liming and green manuring.
(*d*) Distribution of seed potatoes of the varieties that have been found successful.

2. *Introduction of European fruits and fruits of the semi-temperate climate.*—These include apple, pear, cherry, plum, apricot, peach, grape, gooseberry, raspberry, currant, strawberry, fig, walnut, almond, loquat, tree tomato, cherimoyer, and mountain papaya.

3. *Distribution of trees and seeds.*—Of such new fruits and vegetables as have proved successful. These include Australian pear, strawberry, fig, Spanish chestnut, rhubarb, asparagus, and a large fruited variety of squash (*Sechium edule*).

4. *Trial of new crops*—The new crops proposed to be tried next year are three varieties of American sweet potatoes (New Jersey, Virginia and Nansemond), a new fibre called New Zealand flax (*Phormium tenax*), of which seed has been obtained from New Zealand, and Jerusalem artichoke.

5. *Rearing univoltine silkworms.*—The experiment was begun in 1904 and has twice proved very successful. It will be repeated next year, and efforts will be made to popularise this new industry in the Khasi Hills.

6. *Cattle breeding.*—The breed sought to be popularized is the half English breed from Patna.

7. *Introduction of English pigs.*—In the hill districts.

8. *Preservation of fodder in silos.*—Efforts are being made to make silo-making popular among the Khasias.

9. *Trial of certain remedies for insect and fungus pests.*—Recommended by Mr. H. Lefroy and Dr. Butler. These refer to various species of beetles infesting fruit trees at Shillong, and to fungus pests attacking grape, peach, currant and strawberry.

10. *Apiculture.*—Mr. Lefroy has recommended the use of Italian queen bees for crossing with the indigenous bee. Some Italian bees have been indented for from England.

PROGRAMME OF EXPERIMENTAL WORK AT THE TROPICAL PLANTATION AT WAHJAIN IN THE KHASI HILLS FOR 1906-1907.

The plantation is used as the trial ground for various species of tropical spices, drugs and fruits. These are as follows:—

A. Spices.—Cinnamon, Lesser Cardamom, Greater Cardamom, Nutmeg, Clove.

B. Drugs.—Cocoa, Coffee, Camphor.

C. Fruits.—Oranges and other citrus fruits, Kew and Ceylon pine-apple, Bangalore papaya, Grafted mango, Grafted Litchi, Sapota, Banana, Breadfruit, Rambutan, Soursop, Cherimoyer.

D. Miscellaneous.—Caravonica cotton.

It is too early yet to obtain definite results in regard to most of the plants under trial.

SCHEME OF EXPERIMENTS AT THE RANGPUR FARM, 1906-1907.

I. Tobacco for wrappers—(1) Sumatra under shade. (2) Sumatra without shade. (3) Between rows of tall-growing annual plants, such as rahar or castor-oil.

II. Cigar-leaf tobacco for fillers—(1) Cuban. (2) Maryland. (3) Virginia. (4) Yellow Prior. (5) Connecticut-seed leaf.

III. Cigarette tobacco—The same four kinds as are now being grown—Caralla, Isabelli, Suri, and scented leaf.

IV. Ginger (an important local crop)—Compare: (1)Local. (2)Jamaica. (3) Cochin. (4) Calicut.

This will be in continuation of an existing experiment.

V. Potato—varieties, *viz.*, Nainital, Patnai, local, and other good kinds—

Maize, sorghum, cowpea, and such well-known varieties of fine rice (*e.g.*, Kataribhog at Dinajpur), as we have found to grow well here, may be cultivated as demonstrations. There need be no comparative experiments with these.

The present area is not sufficient for any extensive experiment with sugarcane or jute. I would leave them out for the present. A small area of sugarcane may be grown for the purpose of demonstrating improved methods of *gur*-making.

Considering that the entire lowland area becomes one sheet of water during the rains, I should hardly think any reliable results could be obtained from comparative manure experiments with winter rice, which I find mentioned in the cropping scheme for 1905-1906. Some experiments of this nature have been made this year, but I fear the result will be devoid of any value. I gather from what the Superintendent told me that the various plots under experiment were planted at different times, and they are not all of them situated alongside of one another and the plots vary a good deal in level. These facts, combined with the facts alluded to above, namely, all the rice fields being covered with one sheet of water, will rob the experiments of any value they might otherwise possess.

SCHEME OF EXPERIMENTS AT THE GAURIPUR FARM, MAIMANSINGH, FOR 1906-1907.

I. New crops—(1) Wheat. (2) Oats. (3) Barley. (4) Cotton. I have added barley because it is expected to do as well as wheat or oats, and may even do better. I have not much faith in the success of cotton cultivation in the plains. It is very doubtful whether it will be able to compete with jute, and whether its cultivation will pay. However, considering the widespread interest wich it has excited, it may be given a trial at Gauripur. We may try Garo Hills and Dacca tree cotton; also one or two American kinds like "King's improved," of which seed may be had from the Chittagong Farm.

II. New varieties of existing crops—

(1) Potato—Patna and Nainital *versus* local.
(2) Sugarcane—khari, samsara and gandari *versus* local (khari to be tried, also, as ratoons).
(3) Winter rice—(*a*) Balam, Maniki madhuri and Kala Joha *versus* local Kalijira. (*b*) Hatisal *versus* local Lohadang.
(4) *Aus* rice—Peshwari *versus* local Chorarnok.

III. Manure Experiments—

(1) Green manuring for rice—(a two years' experiment: the object being to see whether green manuring followed by *aman* in the first year and by *aus* and *aman* in the second year is better than taking two crops of *aus* and *aman* in each of the two years).
(2) Superphospate and saltpetre against oilcake for sugarcane—My idea is that expensive manures that have to be purchased, if they are at all profitable to use in the present condition of our agriculture, should first prove themselves to be so in the case of the crop which the raiyats consider to be the most valuable, and for which they may be willing to incur some expense. It is no use trying them in the beginning on such crops as rice or jute which yield very much less, acre for acre, than sugarcane.

IV. Seed selection of winter rice—

Much useful work can be done in this direction. We should fix upon the commonest variety of winter rice grown, *e.g., Chapalani*. The experiment is one which should be continued for several years running before any definite result could be expected.

V. Improved gur making.

VI. Use of improved implements—The planet junior hand-hoe, of which there is one in the farm, is a very useful implement. It ought to be regularly used. The farm hands are as yet unpractised in its use. I have shown them how to use it. I am sure once they get practised they will like the implement. The Sibpur plough should also be regularly used.

PROGRAMME OF EXPERIMENTS IN THE CHITTAGONG FARM, 1906-1907.

I.—Crops new to the district—

1. Jute—One good variety, say, *deswal.*
2. Potal.
3. Cotton—Dharwar, King's improved, Garo Hills, Chittagong local, and Dacca tree cotton. It is not intended as an experiment to test the relative merits of these varieties, but only to ascertain whether any one or more of these kinds can be grown successfully and economically in the district.
4. Potato.

II.—Variety experiments—

1. *Aus* rice—To contrast a fine variety introduced from the Central Provinces and a Japanese variety known as *kinshiu* rice with a common local variety (*bâilâm*).
2. Winter rice—

(*a*) Local *rasail* rice *versus* Kataribhog (Dinajpur).
(*b*) Ditto *versus* Dadkani (Burdwan).
(*c*) Ditto *versus* Bansmati („). Badsabhog („). Manikimádhori (Assam). Hatisal („).

3. Sugarcane—

Local *versus khari* and Dacca gandari.
[One or two more varieties may be added].

III.—Manure experiments [with winter rice alone]—

1. Green manuring with cowpea *versus* 100 maunds of village cowdung.
2. Farm cowdung *versus* village cowdung (each 100 maunds).
3. Bonemeal 6 maunds per acre *versus* village cowdung 100 maunds per acre.

[Note effect of bonemeal in the second year.]

IV.—Seed-selection with—1. Local *rasail* rice (winter rice). 2. Local *bailam* rice (*aus* rice).

V.—New implements [Usefulness to be demonstrated by continued working in the farm]—Planet junior hand hoes. "Sibpur" or "Indian" plough. Country rake (*anchra*), not known as yet in Chittagong. Improved *gur*-making appliances (3 roller mill), flat pan, etc.

[Mr. Hadi's apparatus may also be tried.]

VI.—Methods of cultivation—

Ratooning of *khari* sugarcane.

VII.—Utilization of steep hill sides by terracing and planting fruit-trees.

CROPPING SCHEME OF THE RAJSHAHI FARM FOR 1906-1907. (EXPERIMENTAL CULTIVATION).

I. New crops—

1. Potato.—Nainital and Patna (red skinned round, from Shillong).
2. Cotton.—American and Egyptian—3 or 4 kinds. Garo Hills. Dacca tree cotton.
3. *Malachra.*—Malachra Capitata—a new fibre.

II. Variety Experiments—

1. Maize.—Local variety. Kalimpong variety. Shillong variety. Jaunpur variety.
2. Coarse winter rice—*Hatisal* of Assam. Common local variety.
3. Fine winter rice—Bansmati (Burdwan). Dadkani (Dinajpur). Kataribhog (Dinajpur). Badsabhog (Burdwan). Khasagandhi (Cuttack ?). Samudrabali (Burdwan). Maniki Madhuri (Assam). Black Joha (Assam).

[Get fresh seed from original sources.]

4. Autumn rice (*aus*)—Local variety, Central Provinces fine.
5. Sugarcane—Local (*khagra or khari*). Samsara. Dacca Gandari (and one or two more kinds).
6. Wheat.—Local white. Local red. Mozaffernagar white.
7. Jute.—(To be decided in consultation with Mr. Finlow, the Jute expert.)

III. Manure Experiments—

1. Winter rice (local variety)—Try (1) Bonemeal 6 maunds per acre *versus* no manure. (2) Green manuring with *Dhanchi versus* no manure. (3) Green manuring with cowpea *versus* no manure.

[Observe effect in the second year.]

2. Sugarcane (local variety)—

Try (1) Cowdung 150 maunds per acre *versus* cowdung *plus* castor cake 20 maunds per acre *versus* castor cake 20 maunds per acre. (2) Similar experiment with bonemeal 6 maunds per acre substituted for castor cake. (3) Similar experiment with bonemeal 6 maunds per acre and saltpetre 1 maund per acre in place of castor cake.

IV. Implements—

1. Soil-investing plough *versus* country plough } For winter rice.
2. Ditto. } For wheat.
3. Demonstrate the improved method of sugar-making invented by Mr. Hadi, Assistant Director, United Provinces.
4. Demonstrate the use of planet junior hand-hoe and wooden clod-crusher.

V. Seed selection—

Try (1) Common local coarse variety of winter rice. (2) Common local fine variety of winter rice. (3) Local maize. (4) Jute (as decided by Mr. Finlow).

B. C. BASU,

Assistant to the Director, Department of Land Records and Agriculture, Eastern Bengal and Assam.

PROGRAMME OF WORK FOR THE AGRICULTURAL DEPARTMENT IN MYSORE.

Chemical Laboratory :—

1. The completion of the analyses of 56 samples of coffee with a view to gathering any information in regard to quality of coffee.

2. The analyses of "famine foods" to determine their nutritive value.

3. The analyses of fertilizers, general routine analytical work, and work connected with experiments, especially with sugarcane, and the manufacture of raw centrifugal sugar and juggery, including extraction of juice from the cane by different mills.

4. Experiments connected with the retention of soluble fertilizers in highly ferruginous soils, especially in regard to phosphatic fertilizers.

Pot-culture House :—

1. To study the difference in growth of various agricultural plants when grown in pot-culture house, in the covered yard, and in the open field; and to investigate other factors affecting the growth of plants in pots in a tropical climate—preliminary work.

2. To study the availability of bonemeal in various soils and conditions, and to try to determine the value of phosphate of iron for dry crops.

Experimental Farm—

The Experimental Farm was acquired this year, laid out into oblong plots of $\frac{1}{10}$ acre (50 links × 200 links), the wet area sown with paddy and the dry lands with *ragi*. These crops show that there is considerable difference in some of the plots. After the present crops have been harvested and weighed, definite plans will be made for next year. To overcome unevenness caused by previous cultivation and manuring, it may be necessary to treat the entire area quite uniformly for another year, and in that case no experiments can be made. If experiments can be begun, the effects of green manuring in its various phases, cultivation immediately after the crop is removed (if possible), different depths of cultivation, the effects of farm-yard manure produced in a box stall and by the ordinary Indian method will be compared with each other and with some of the commercial fertilizers. Different dates of sowing of various crops and different methods of sowing will be compared as far as circumstances will permit on the dry lands. On the wet lands somewhat similar experiments will be conducted with paddy and sugarcane, as far as time, space and opportunity will permit. Variety experiments will take a secondary place to the above.

A. LEHMANN,

Agricultural Chemist to the Government of H. H. the Maharaja of Mysore.

APPENDIX H.

CURRICULA OF STUDIES AT PROVINCIAL AGRICULTURAL COLLEGES.

MADRAS.

Extract, paragraphs 1—3, of letter from C. Benson, Esq., M.R.A.C., Deputy Director of Agriculture, Madras, No. 2806, dated the 11th November 1905.

In continuation of my letter No. 2616, dated the 20th October 1905, I have the honour to submit herewith memorandum on the curriculum to be adopted in Provincial Agricultural Colleges, in which I have embodied remarks on Mr. Barber's suggestions which were forwarded to me with your un-official No. 155, dated the 2nd November 1905.

2. I showed the draft of this memorandum to Mr. Barber, and he has shown me a draft of a supplemental letter he is addressing the Board on the subject. I do not wish to add any further remarks with reference thereto, except to say that it shows that one subject which the Board of Agriculture will have to fully consider is what staff will be required for carrying on the work of Agricultural education satisfactorily at Provincial Colleges and Schools.

3. For convenience of reference, I enclose file * of the syllabuses at present in force here, except that in Agriculture, which should be as printed in B.* P. No. 215, dated the 13th October 1902.

* * * *

Memorandum.

As a basis for the discussion of the subject, the Inspector-General has asked for recommendations as to the curriculum which should be adopted in Provincial Agricultural Colleges. To this end, I would suggest that the scheme drawn up by the Committee which sat here rather more than four years ago should be forwarded to him. With that scheme, I am still in agreement, though I think that it is capable of improvement.

The essential points of that scheme are that the purely scientific preliminaries and elementary subjects which go to make up a full agricultural training should, as far as possible, be finished during the first two years of the course and the last year should be devoted to their application. The scheme includes the following subjects:—

General Chemistry.
Botany.
Meteorology and Geology.
Anatomy and Animal Physiology.
Agricultural Engineering (including Surveying).
Veterinary Hygiene.
Agricultural Chemistry, and
Agriculture.

A study of the first four subjects is necessary to that of the last two, and without some knowledge of Agricultural Engineering and Veterinary Hygiene, no agricultural education or training can be complete. The syllabuses then prescribed indicate approximately the extent of the studies that is necessary in each subject, but I would add the following remarks on the different subjects.

General Chemistry.—In this syllabus, I think it possible that Dr. Leather, who drew up the syllabus, has included more than is essential to the proper understanding of the matters embraced in the syllabus of Agricultural Chemistry, which, it will be seen, covers most of the purely scientific aspects of Agriculture in both its branches.

Botany.—The scope of the studies necessary in this subject seems to me to be very fairly indicated in the syllabus, though it may, no doubt, be improved on. The syllabus was drawn up by Dr. Bourne in consultation some years

* Not printed.

before the sitting of the Committee mentioned. I am, however, entirely in agreement with the Committee in thinking that it should be developed in the way of "the diseases of field and garden crops." If this be done, all that is required in Botany by an agricultural student would be provided. The question whether that side of Agriculture which deals with farm crops should be the function of an Economic Botanist or an Agriculturist is a different one and will be referred to below.

Meteorology and Geology.—There is no essential connection between these subjects, but the syllabus indicates the amount of attention that should be given to matters which may be so described.

Anatomy and Animal Physiology.—Though the syllabus appears rather extensive, the reality altogether depends on how it is applied, and though it is probably capable of improvement, it will serve sufficiently as a basis for discussion, which, I understand, is the main thing required at present.

Agricultural Engineering.—In this subject, I think that the scheme at present in force is faulty, and especially is it so because it is designed to serve two ends. It should include just so much *Surveying* as is indicated in the syllabus sanctioned in G. O. No. 363 * Educational, dated the 30th July 1903, it may omit the *Levelling* there shown, the whole of the treatment of Irrigation, there prescribed, may also be omitted, the portions relating to *Building construction* and *Road-making* may probably be simplified, but the portion dealing with *Machines* should be somewhat developed, seeing the advances which are being made towards the application of mechanical power to agriculture in India.

Veterinary Hygiene.—Here, also, I think that the scope of the training should be somewhat reduced and some of the matter should possibly be treated by the Agricultural Professor.

Agricultural Chemistry.—I do not see how this is to be cut down and an adequate agricultural training given. Moreover, the subject cannot be properly dealt with until the students have acquired some considerable knowledge of both Animal and Vegetable Physiology, besides, of course, a fair knowledge of Chemistry.

Agriculture.—This is the crux of the whole matter and the scope of the subject, as it should be dealt with, is indicated in the syllabus printed in B. P. No. 215,† dated the 13th October 1902. With so vast a subject as is there indicated, some portions of which are capable of being appreciated by any one of average intelligence and to the comprehension of some of which all the other items of the course subserve, and most of which has to be or should properly be illustrated when dealt with by what can be shown in the field, it seems to me that it should be extended throughout the course, and, what is not provided for in the scheme under discussion, that the progress should be tested from time to time.

I have already also said that I think that the matter of the diseases of the farm crops should be dealt with under Botany, which should not be hard to provide when the Mycologist, whom the Government wish to obtain, has been secured; and I also think that Entomology, *i.e.*, "the insect pests of field and garden crops," and "Sericulture" should be separately provided for. Even when this is done, I regard the work of teaching the subject as far too heavy for one man, whatever native Assistants, such as are available at present, he may have, if he is also to carry on the management of a large experimental farm and the administration of the College and Institute. It is possible that the Agricultural Professor might, in some cases, be able to delegate the teaching in some branches of Field Husbandry to an Economic Botanist and could then undertake General Agriculture and Animal Husbandry himself; but such an arrangement would not, to my mind, be a satisfactory one, for it would almost infallibly lead to the treatment of crops as separate entities and not as parts of a whole system of Agriculture. And then again there is the further objection of perhaps, under such a system, having to force a round man into a square hole.

I am most strongly of opinion that, for dealing with Agriculture adequately, two Professors will be needed and should be provided in every Provincial Agricultural College, and more especially so when one of them is to be Principal of a Central Research Institute.

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* Not printed. † Not printed.

What I suggest is that the scheme of 1901, as shown in the syllabuses, but not necessarily the scheme for examinations, be laid before the Board of Agriculture at its next meeting.

Turning now to Mr. Barber's note, forwarded to me with un-official No. 155, dated the 2nd November 1905, I would first remark that in one essential we are in entire agreement—namely, that the scientific grounding necessary to a training in the art of Agriculture should be the first thing aimed at in any scheme. If, too, he can work out a satisfactory scheme or syllabus of study in Elementary Biology which would include what is needed in Botany, Zoology and Animal Physiology—to be dealt with as one subject—I have no objection to raise, and Mr. Barber can, no doubt, speak with far more authority on the amount of time required for this teaching than I can. As to what he terms Physical Science, however, I do not think the combination suggested at all likely to be productive of good results, for the standard of work in Geology and Physics would be far lower than that essential in Chemistry, and, judging from experience, I do not think that a sufficient knowledge of Chemistry alone can be acquired by native students with less than two years' work. At the same time, I do not think it desirable that the class-room work on Agriculture should be altogether deferred, but it should begin in the first year; whilst it is most desirable that, if possible, such a subject as Agricultural Engineering, which does not demand a preliminary study of Natural or Physical Science, should be dealt with at the very beginning of the course.

In Mr. Barber's second year course, our ideas do not agree, whilst, if my conception of what is desirable with regard to Physical Science and as to the other work which should be taken up during the first year be accepted, it is not likely that the students would have got so far all round as to be able to go on as he suggests. However this may be, I think that the general idea of the development of the course is sound, but whether it is desirable to depend on the Botanist or the Agriculturist for dealing with crops must be decided solely with reference to the *personnel* of the staff available at the time. The former, if no Entomologist or Mycologist be available, would probably be better qualified to deal with plant pests and diseases than the latter in any case, and in the ordinary course, I would limit the development of Natural Science thereto, although perhaps the subject of Veterinary Hygiene might also be so included.

As already stated, I do not think that the students would or could be sufficiently advanced in Chemistry to take up Agricultural Chemistry properly in their second year, and I also think that Agriculture itself should receive attention throughout the course, besides what it receives in the field; but it is not usually advisable to attempt to deal in detail with particular crops until the preliminary matters of tillages, irrigation, rotations, etc., have been treated.

As to the third year course, there is no essential difference of opinion between Mr. Barber and myself, though I think that it will not be until that time that what is known as Agricultural Chemistry can be taken up. This third year should be devoted entirely to applied science and agricultural practice and before any student is allowed to enter on it, he should be thoroughly tested in all preliminaries, and these should include any matters agricultural, in connection with which a preliminary knowledge of science is not essential.

In making these remarks I have it in my mind that an Agricultural College should turn out, as far as such an institution can, men thoroughly equipped for starting on agricultural work— it cannot equip them with experience or the business aptitude which go so far to the making of a successful agriculturist—and not be designed to the training of mere managers for small stations where attention is to be limited to a few problems. At the first start the demand for that class of men may be the chief one to meet, but it would be a mistake to limit the scheme of training by any pre-conceived idea of what qualifications would suffice in such men. And even on this point, I am not altogether in agreement with Mr. Barber, but it is not necessary to press the point here and now.

Another point of great importance is what standard of general education is to be demanded before any student can be admitted to the course. If a

good general education and some previous knowledge of science is to be demanded, the students must be graduates in science at the University. That is not, I think, feasible or even desirable, but the point is a very important one in its bearing on the capacity of the students in Agriculture for appreciating what will be taught and in the amount of preliminary teaching that will be necessary. A good knowledge of English is essential.

C. BENSON,

Deputy Director of Agriculture.

Memorandum on Agricultural Education in Provincial Colleges.

It would be well, in the first place, to remember that Agriculture is not a science but an industry. In this respect it resembles Forestry, but it is an industry which calls for assistance from an extraordinary number of sciences, such as Botany, Chemistry, Animal Physiology, Geology, Veterinary Science, Entomology, Mycology, Surveying, Engineering, Physics and a certain amount of Bacteriology in connection with dairying and the biology of soils.

Some knowledge of all these sciences is necessary for a full agricultural equipment, but obviously such knowledge cannot be obtained in an ordinary technical college. We may, I think, take it as a rule that, with a good education and some previous knowledge of the subject, the elements of a science may be mastered by a year's hard work, and the most rapid workers in English Universities have been unable to obtain this elementary knowledge in more than three subjects in two years' continuous hard work, although carefully prepared beforehand.

Allowing, then, two years in an Agricultural College for the preliminary scientific grounding, it will be obviously impossible to teach the elements of the sciences mentioned above, with the use of the ordinary text-books. The scientific training will have to be cut down to the lowest possible minimum and even the science taught must be off the beaten track and have a distinct agricultural bearing.

My opinions on the subject are not based upon any actual agricultural teaching. I was, however, Professor in the Forestry Branch of the R. I. E. College at Cooper's Hill for three years, and I base my remarks—

(1) on a knowledge of the scientific subjects taught to the Forestry men at Cooper's Hill;

(2) on my experience of the attainments and requirements of Forestry officers in India;

(3) on my knowledge of what is wanted to make a successful manager of an agricultural farm in Madras.

I have examined with care the report of the Agricultural College Committee printed in B. P. No. 215, dated the 13th October 1902, and I notice that although most of the subjects are admirably dealt with, there is still a tendency to try and teach more science than it is possible for the students to learn in the time. This is especially the case with Chemistry which, from the syllabus, *should* take as much time as all the other sciences put together. I presume that this prominence given to Chemistry is due to the fact that a Chemist was the only scientific man in the Committee. Some knowledge of Chemistry is undoubtedly necessary to understand the soils and manures and the elements of Botanical Physiology. But what need has a successful manager of farms for a knowledge of "*Cyanogen and Derivatives*, Cyanogen, Hydrogen, Potassium and Silver Cyanides, Potassium ferro-cyanide, Potassium ferri-cyanide, Cyanic acid, Potassiuum sulphocyanide," and much more of the same character on page 8 of the B. P.? It is even doubtful, with a Superintendent of Farms or Agricultural Chemist in the country, if the manager of a farm will ever be required to draw up the simplest scheme of manurial experiments, while with the analysis of the soil and vegetable products he has nothing to do. An Agricultural College is no place for the teaching of pure science, and I maintain that the syllabus in Chemistry is entirely beyond the scope of a technical college with a three years' course in Agriculture.

Owing to the number of sciences concerned, it will be obviously impossible either to obtain a separate lecturer for each or even to give a separate course

in each. A certain amount of amalgamation will therefore be necessary. It is proposed to allow a superior staff of three—an Agriculturist, a Botanist and a Chemist; and the following suggestions are based upon that idea. The general line of work should be to proceed from the scientific to the technical, and at the same time from the simple to the advance. There is no part of a science more advanced than its correct technical application. I would suggest as a general rule that three hours of teaching in the class rooms is quite sufficient for any one day. An average student is incapable of assimilating more. The scheme here prepared a lows for one lecture and two hours' practical work each day throughout the three years.

I would devote the first year's teaching to the elements of Natural and Physical Science, the second year to the application of these to Agriculture, and during the third year I would place the students directly under the Agricultural Professor to be taught the principles of Agriculture. During the whole of the three years I would give the men two to three hours in the fields each day, and probably more during the third year. The actual teaching in the class rooms I would limit to three hours a day, and I think that at least two hours should be devoted towards the end of each day to writing up the notes for the day and preparation for the next day's work. In all cases I have put down three hours' teaching each day, usually divided into one hour's lecture and two hours' practical work, but the exact sub-division of this period of academic teaching might be arranged by each Professor as suited his subject.

The following scheme is suggested :—

First year.

Natural Science, including Elementary Biology, the elements of Botany, Zoology and Animal Physiology. Lecture one hour, practical work two hours. Three times a week throughout the year.

Physical Science, including Physiography and the elements of Geology, Physics and Chemistry. Three hours a day on days alternating with the Natural Science lectures throughout the year. I would hold an examination in science at the end of the first year, for I know from experience that examinations are the only things to make some people work.

Second year.

In the second year I would apply the rudiments of Physical and Natural Science to certain portions of the farm work. The Natural Science would be developed in the direction of Economic Botany and Veterinary Science, while the Physical Science might be expanded in the direction of Chemistry and Engineering with Surveying. These courses might be suitably defined as Agricultural Botany, Agricultural Chemistry, Agricultural Physics and so on. There would be four equal courses, the details of which would have to be developed by the lecturer. Economic Botany would include a study of the crops in Madras, their commoner pests, whether insect or fungoid, the elements of geographic distribution of crops, oecology of plants, heredity, cross-breeding, etc.

Each course would occupy one term, three hours a day, three times a week. One hour for lecture and two for practical work. I would recommend an examination at the end of the second year, although this is less necessary than those at the end of the first and third years. The teaching in the second year would no longer be pure science and might be considered as an integral part of Agriculture.

Third year.

In the third year I would place the students entirely under the Principal with one or two competent native assistants. The students should have a full course on Agriculture. It might be left to the Principal to deal with any subject taught in the second year more fully if he found it desirable. Special courses, such as Dairying, Farm Management, Accounts, etc., should be included in the farm work. At the end of the third year, an examination should be held in Agriculture in its widest sense.

The course thus outlined would furnish us with students having a general knowledge of the principles of agriculture with some experience in farm work

and management and a good idea of what assistance could be obtained on reference to the various scientific experts. Such men could be drafted at once on to the farms as Assistant Managers. If it is thought necessary to afford a training for teachers of the College or Assistants in the laboratories of the various specialists, promising students might be sent for a further course of two years at Pusa, but, considering the local Madras conditions, I think it would be preferable if those showing aptitude in any particular direction were made pupil teachers in the College or apprenticed to the various specialists in the Agricultural Department.

It will be useless to go into detail regarding the various syllabuses in the College courses. This may be dealt with by a Committee if desired, but if such a Committee is called together, it should contain representatives of all the sciences required, and the first duty of such a Committee would be to apportion the *time available for each science according to importance from a practical agricultural point of view.*

The staff required to carry out the scheme would not be large. Three whole-time European Professors in Biology, Physical Science and Agriculture. Competent native assistants one each for the Biologist and Physicist and two for the Agriculturist. The latter will also require the assistance of the farm officers for carrying out the practical work during the first two years. An assistant will be required in veterinary Science and another in Agricultural Engineering and Surveying. The working of this limited staff with this limited programme would be very heavy, and it is idle to imagine that they need not be whole-time Professors.

C. A. BARBER,
Government Botanist, Madras.

Letter from C. A. Barber, Esq., Government Botanist, Madras, No. 284, dated the 10th November 1905.

In continuation of my memorandum of the 31st ultimo on Agricultural Education, I have the honour to state that it was drawn up on the understanding that I should not have an opportunity of discussing the matter with the Deputy Director of Agriculture. I have now had this opportunity, and Mr. Benson has shown me a draft letter containing his views on the subject with criticisms upon my memorandum. I am glad to find myself in general agreement with that draft. But, as it appears that I have not been myself clear on certain points, I subjoin the following remarks, it being all along understood that such a scheme as the one I proposed must inevitably depend upon the staff available and the qualifications of the individual Professors.

2. The scheme was drawn up for three whole-time Professors and an endeavour was made to divide the work as equally as possible. An elementary study of plant foods is of course included in Botany under the sub-head Physiology. The study of the crops and their pests and the principles of cross-breeding have been delegated to the Economic Botanist. I consider that it is advisable that the crops should be studied early, so that when the agricultural Professor deals with them, the students will have a good knowledge of their biological characters and chief products.

3. It is not supposed that students in the college will, as a rule, have any previous knowledge of science. The main object of the course is to provide managers of local farms, but there is no reason why, as time goes on, the scheme may not be expanded, so as to give the superior training which Mr. Benson desires.

4. As regards the course in Physical Science, it is obvious that the subjects dealt with will require a very different amount of time, and Chemistry would probably take up a good deal more than the rest. My criticism regarding this subject in the syllabus refers entirely to *General Chemistry* and *not* to the Agricultural Chemistry. It is difficult to separate the latter subject from Agriculture, but I would like to confine the purely chemical part to the second year. If it is thought that the lectures are too close together (three times a week), the course might be continued through the whole of the second year, at less frequent intervals.

I would desire that the whole of the course in Physical Science should be made as elastic as impossible. If the modifications suggested will not allow time enough, a part of the time devoted to Veterinary Science might be used. I regard it as impossible to teach the students the Science of Chemistry so as for them fully to understand the chemical processes in agriculture, and where this is the case, I think that the knowledge imparted should be empirical.

5. I am in agreement with Mr. Benson what it would be a good thing to teach certain portions of Agriculture from the beginning. The study of soils, for instance, might be included in Physiography and Geology and there might be found time to introduce Agricultural Engineering earlier in the course as a part of practical Physics, but I would deprecate any change which would prevent the whole of the science as such from being completely finished in the first two years.

BOMBAY.

PROPOSED REVISED CURRICULUM OF STUDIES FOR THE AGRICULTURAL COLLEGE, POONA.

First Examination in Agriculture.

Subject I.—MATHEMATICS AND PHYSICS. (Two papers and one practical.)

1. MATHEMATICS.—Mensuration and Surveying (one paper and a practical).

Mensuration.—*Areas*; of plane surfaces including land, roofing, brickwork, etc.

Volumes; of solids, regular and irregular, including capacities of tanks ponds and wells.

Estimation; of quantities of materials for walls, roads, buildings, excavations, embankments, and so forth.

Weight; of hay, cattle, and so forth.

Surveying.—Construction of scales. Surveying by the chain and cross-staff. Field book. Surveying compass. Method of plotting surveys. Levelling. The Y and Dumpy levels and their adjustment. Levelling. Field book. Bench marks.

The practical work should include the dividing of fields into plots of different areas for agricultural experiments; the laying out of farm roads, water-courses to serve irrigated fields and the drawing of a rough plan of a farm building.

2. PHYSICS.

General.

The measurement of length, area, volume, mass, density, time.

Uniform, uniformly accelerated motion.

Force, weight as distinguished from mass, stress, pressure, tension.

Energy.—Work, power or activity, horse-power, energy of gravitational separation or potential energy, energy of motion or kinetic energy, transformation of energy.

Conservation of energy, the pulley, lever, inclined plane, wheel and axle, screw and pendulum as illustrating the principle of conservation of energy.

Apparent exceptions to the law of the conservation of energy, friction, heat produced by friction, heat is a form of energy and can be measured in mechanical units or in other units which are not used in mechanics.

The balance.

The different states of matter, solid, liquid and gas.

Cohesion.

Solids.—Elasticity, strain, stretching, bending, compression torsion, elastic limit.

Energy stored in springs.

Strength of materials.

Hardness, tempering, annealing, ductility, malleability.
Structure, homogeneous, fibrous, crystalline, laminar.
Liquids—General properties.
Pressure per square centimeter, and resultant force due to pressure on a surface, transmission of pressure, principle of Archimedes.
Specific gravity of solids and liquids, hydrostatic balance, specific gravity bottle.
The hydraulic press, water level, spirit level, artesian wells.
Efflux of liquids, flow through tubes, viscosity.
Energy stored in high reservoirs of water, water-wheels, turbines.
Solution, diffusion, osmosis, capillarity.
Gases.—General properties.
Compressibility, Boyle's law.
Kinetic theory of gases, Avogadro's hypothesis.
The atmosphere, barometer, aneroid.
Isobars, cyclones and anticyclones.
Effect of height on the barometer.
Manometers, steam-gauge, air-pump.
Water pump.
Storage and transmission of energy by means of compressed air.

Heat energy.

Expansion of solids, liquids and gases by addition of heat energy with practical examples.
Temperature, thermometers (liquid and gas), maximum and minimum thermometers.
Co-efficients of expansion of solids, liquids and gases, variation of density with temperature, density of gases.
Measurement of heat energy, the caloric specific heat.
Calorimeters, method of mixture, ice calorimeter, physiological calorimeter.
Conduction of heat in solids and liquids, convection in liquids and gases.
Wind, land and sea breezes, trade winds, monsoons, the general circulation of the whole atmosphere at different seasons of the year.
Transformation of heat energy into radiant energy.
Transmission of radiant energy through the ether or radiation.
Absorption of radiant energy.
Change of state, fusion and solidification.
Heat of fusion, change of volume on fusion, effect of pressure.
Freezing mixtures.
Evaporation, factors influencing its rapidity.
Tension of vapours.
Dew, dew point, hygrometers.
Boiling, variation of boiling point with pressure.
Heat of vaporisation.
Density of steam.
Transformation of heat energy into mechanical energy in the steam engine.
Distillation.
Cooling by evaporation.
Sources of energy.
Solar radiation, terrestrial heat, tides.
Solar radiation converted into energy of chemical separation by green plants; also the source of wind and water power.
Methods of converting other kinds of energy into heat energy, friction, compression, percussion for mechanical energy, absorption for radiant energy, chemical union for energy of chemical separation in dead matter, or in the bodies of animals, passage of an electrical current through a resistance for electric energy.
Cooling by expansion of gases.
Production of cloud and rain by rising currents of moist air.

Energy of Magnetic Separation.

Nature of magnets, magnetic attractions and repulsions.

Lines of force.
The earth a magnet, magnetic compass, declination.
Magnetic properties of iron.

Energy of Electric Currents.

Simple electric cells—Daniel and Grove.

Laboratory Course.

List of practical exercises.
About twenty to be selected for any set of students.

1. Construction of vernier scales for measurement of length and angles.
2. Measurement of metal sheets, wires and other regular solids with vernier calipers.

Calculation of volumes, weighing and determination of densities.

3. The same measurements with the screw micrometer.
4. Density of a solid by weighing and then displacing water in a partly filled graduated vessel with the solid.
5. Specific gravity of heavy solids with the hydrostatic balance.
6. Specific gravity of light solids with the hydrostatic balance.
7. Specific gravity of liquids with the specific gravity bottle.
8. Specific gravity of solids with the specific gravity bottle.
9. Specific gravity of solids with Nicholson's hydrometer.
10. Specific gravity of liquids with hydrometers. Construction of a hydrometer scale.
11. Joly spring balance. Construction of a curve showing relation between stretching and weight.
12. Simple pendulum.
13. Study of accelerated motion with a ball running down an inclined plane and on to a level tract.
14. Measurement of the energy required to raise a body moving with rolling friction from the bottom to the top of an inclined plane.
15. Measurement of the energy required to raise a body a certain distance by means of different combinations of pulleys.
16. Measurement of the energy required to raise a body a certain distance by means of the wheel and axle.
17. Measurement of friction between different surfaces by means of the inclined plane.
18. Breaking weights.
19. Viscosity by time of flow from pipettes.
20. Solubility of different substances.
21. Capillarity with tubes.
22. Capillarity with plates.
23. Boyle's law.
24. Daily or weekly readings at stated times of the thermometer, barometer, maximum and minimum thermometer and wet bulb thermometer. Annual curves to be drawn.
25. Construction of a water thermometer.
26. Expansion of a gas at constant pressure.
27. Specific heat, method of mixture.
28. Heat of fusion of ice.
29. Heat of vaporisation.
30. Observation from day to day at different temperatures of vapour tension in barometer tubes containing water, alcohol and ether.
31. Hygrometers.
32. Observation of magnetic attractions and repulsions, sketching lines of force as shown by iron filings for different combinations of magnets.
33. Tracing lines of magnetic force with small suspended magnet needle.
34. Setting up and use of the electric battery.
35. Electrolysis of water and simple electrolytes.

First Examination in Agriculture.

Subject II.—(Two papers and a practical examination.)

1. Inorganic Chemistry.

Introductory definitions.—Molecule, atom, element, compound, mixture; symbols, formulæ; chemical action, equations, molecular and atomic weights, valency, nomenclature.

The Atmosphere.—Has weight; Complex mixture of gases: Rusting and burning: Two chief constituents are Oxygen and Nitrogen: Other substances present in air are water-vapour, Carbon dioxide, Ozone, Nitric Acid, Ammonia, Argon.

Reasons for considering air a mixture.

Water.—A compound of two gases—Oxygen and Hydrogen. Synthesis and analysis of water. Volumetric and gravimetric composition.

Reasons for considering water a compound. Different states occurring in nature. Water of crystallisation.

Hard and soft waters. Saline impurities.

Organic impurities, water as a solvent. Gases in solution.

Oxygen.—Distribution in nature: preparation, properties. Oxidation. Basic and acid oxides. Salts. Ozone: Allotropy.

Hydrogen.—Preparation, properties, compounds with oxygen; Halogens—General characteristics; compounds with hydrogen.

Sulphur.—Extraction, properties; compounds with Hydrogen and Oxygen; Sulphuric acid; sulphates.

Carbon—Occurrence, description and properties; allotropic forms; oxides; carbonates; relation of Carbonic Acid gas to plant life.

Silica.—Occurrence, description, properties; Silicates.

Nitrogen.—Preparation, properties; Compounds with Oxygen and Hydrogen. Nitric Acid.

Phosphorus.—Preparation, properties. Allotropic forms. Compounds with Oxygen. Phosphoric acids and phosphates. Relation to plant life.

Arsenic.—Description, properties, compounds with Oxygen; Arsenates.

Boric Acid and Borates.

Metals.—General properties of—

(*a*) Alkaline metals.

Potassium.—Description, properties, compounds; chloride, hydroxide; sulphate, nitrate, carbonates; relation of potash to plant life;

Sodium.—Description and properties, compounds; chloride, hydroxide, sulphate, nitrate, phosphates, carbonates, silicates, glass.

Ammonium.—Theory, chloride, sulphate, carbonates, phosphate.

(*b*) Metals of alkaline earth.

Calcium.—Description, properties, compounds; oxide, hydroxide, chloride, sulphate, phosphate, carbonates; lime burning; bleaching powder.

Magnesium.—Description and properties, oxides, chloride, sulphate, carbonates.

(*c*) Earthy metals.

Aluminium.—Distribution, description, properties, oxide, sulphate; alums, clays.

(*d*) Useful metals.

Iron.—Description, properties, compounds; oxides, sulphides, sulphates; steel, wrought and cast iron; manufacture and properties.

Lead.—Description, properties, oxides, sulphide, sulphates, white lead. Action of water on lead.

Copper.—Description and properties, oxides, sulphides and sulphate; Antiseptic properties of solutions of copper.

Zinc.
Manganese.
Nickel.
Tin.
} General description; chief uses, and compounds.

(*e*) Precious metals.

Mercury.—Description and properties, oxide, chlorides, sulphide.

Silver.—Chief compounds—chloride nitrate.

Gold and *Platinum.*—Description and properties; chloride.

Laboratory.—Detection by dry and wet methods of analysis of the following metals and acid radicles, the mixtures containing not more than two metals and two acids.

Metals.—Sodium, potassium, ammonium, magnesium, calcium, copper, aluminium, iron and manganese.

Acids.—Chlorides, sulphides, sulphates, nitrates, phosphates, carbonates and silicates.

2. MINERALOGY.

Description and chemical composition of the common minerals, quartz, felspar, mica, hornblende, limestone, etc.

Rocks.—Component minerals of rocks, especially those of the Bombay Presidency; mines and quarries of the Presidency.

Practical work.—Ability to recognise the above minerals and rocks.

Subject III.—BOTANY—(One paper and a practical).

(*a*) *Morphology.*—The plant in general. Special morphology of the root, stem, leaf, inflorescence, flower, fruit and seed, with special reference to Indian, examples.

(*b*) *Anatomy.*—The cells; its constituents and development. Tissue systems, epidermal, fibrovascular and fundamental. The arrangement of these systems in Dicotyledons and Monocotyledons.

(*c*) *Physiology.*—Functions of the cells and tissues in the different parts of plant bodies. The food of plants and the processes undergone in its elaboration. The circulation of water and gases in plants. Process of growth. Phenomena of movement. General conditions of plant life; influence of air, moisture, heat, electricity, gravitation, etc. Reproduction of flowering plants. Fertilization. Hybridization. Alternation of generation. The process of germination.

Practical.—Description of specimens. Identification and description of typical sections under the microscope.

Subject IV.—AGRICULTURE—(Two papers and a practical).

1. GEOLOGY.—(One paper).

World Formation.—Nebular hyphothesis—Earth, its present condition. geological ages.

Rocks.—Their age and formation; agencies, such as heat, water and organic matter. Classification—Stratified, igneous, metamorphic; fossils, formation of coal and its distribution. Principal rocks of the Presidency.—Trap, laterite, murum, granite, gneiss, etc.

GEOLOGICAL PHENOMENA.—Earthquakes, volcanoes, hot springs, central heat.

2. SOILS.—(One paper and a practical).

Formation of soils.—Source, agencies, classification according to formation. Soils of the Presidency and rocks from which they are formed.

Physical composition of soils.—Clay, sand, organic matter, water, air, etc.

Physical properties of soils.—Texture, friability, porosity, imperviousness, expansion and contraction.

Temperature of soils.—Source of heat, capacity of the soil to absorb and retain heat, conductivity, radiation.

Soil moisture.—Its origin, capacity of the soil to absorb and retain moisture; influence of water on the physical condition of the soil. Movement of soil-water. Drainage, capillarity, evaporation, water-table. Physical effect of irrigation, of water-logging and inundation.

Effect of salts on movement of soil-water.

I.—Soils and their management.—Agricultural classification of soils and characters of each class. Revenue classification of principal soils of the Presidency and local names given to the same.

Sub-soils.—Characteristics, kinds, and their effect upon the surface soil. Productive and unproductive soils. Fertility, effect of physical conditions, effect of moisture, of location of poisonous substances.

Treatment of soil to increase production.—Fallowing, rabing, mixing draining, irrigating, water-lift fittings. Tillage implements, indigenous and western, including sowing implements.

Practical work.—Ability to use all the farm tillage implements by actual manual labour, for example, ploughing, harrowing, using the seed-drill and intertilling implements, adjusting the ropes in the proper manner to the indigenous implements and to do all the farm operations, such as straight sowing, transplanting, harvesting, etc.

Second Examination in Agriculture.

Subject I.—ORGANIC CHEMISTRY— (One paper and a practical examination).

Composition and analysis of organic compounds—qualitative and quantitative. Deduction of a formula from the results of analysis, and determination of molecular formula.

Constitution or structure of organic compounds. Polymerism. Isomerism. Radicles, Homology. Physical properties of Organic Compounds.

General classification.

The saturated and unsaturated Hydrocarbons and their Haloid derivatives in general. Methane, Ethylene, Acetylene. Chloroform.

Monohydric, Dihydric and Trihydric alcohols. Methyl Alcohol. Ethyl Alcohol. Fermentation. Ethylene Glycol. Glycerine. Fats.

The Ethers.—Ethyl Ether.

Aldehydes and Ketones.—Formic Aldehyde. Acetic Aldehyde. Acetone.

The Fatty Acids.—Formic and Acetic Acids. Acetates of the alkalies and of lead. Butyric acids. Palmetic, Stearic and Oleic acids. Soaps.

Hydroxycarboxylic acids—Glycollic and Lactic Acids.

Dicarboxylic Acids—Oxalic Acid.

Hydroxytricarboxylic Acids—Malic and Tartaric Acids.

Hydroxydicarboxylic Acids—Citric Acid.

Cyanogen Compounds.—Cyanogen, Hydrocyanic Acid, Potassium Ferrocyanide and Ferricyanide. Urea and Uric Acid.

The Amides of the Fatty Acids.—Acetamide.

Carbohydrates.—Cane sugar. Dextrose. Levulose. Maltose. Glucose. Starch Dextrin. Cellulose.

Application of the Polariscope to Sugar determination.

Benzene derivatives in general. Benzene, Nitrobenzene. Amidobenzene.

Phenols and Aromatic Acids.—Carbolic and Benzoic Acids. Salicylic Acid. Gallic Acid. Tannin.

Indigo.

Alkaloids.—Nicotine. Morphine. Quinine. Strychnine.

Terpenes and Camphors.—Pinene. Caoutchouc. Japan and Borneo Camphors.

Resins, Glucosides, Albumens and Albuminoids in general.

Amygdalin.

Practical work:—

Simple organic preparations. Methane, Ethylene, Ethyl Alcohol, Acetic Acid, Chloroform, Urea, Soap.

Determination of Chlorine, Sulphuric, Nitric and Phosphoric acids and of the following bases:—Copper, Iron, Aluminium, Calcium, Magnesium, Potassium.

Subject II.—BOTANY—(One paper and a practical examination).

Classification and description of plants; general principles followed in the chief artificial and natural systems; the comparative values of both methods.

Flowering plants.—Dicotyledons, Gymnosperms, Monocotyledons. Diagnoses of the following Natural Orders with Indian examples:—Cruciferæ, Malvaceæ, Lineæ, Rutaceæ, Ampelideæ, Anacardiaceæ, Moringeæ, Leguminosæ,

Rosaceæ, Myrtaceæ, Cucurbitaceæ, Umbelliferæ, Rubiaceæ, Compositæ Sapotaceæ, Apocynaceæ, Solanaceæ, Labiatæ, Amarantaceæ, Polygonaceæ Piperaceæ, Loranthaceæ, Euphorbiaceæ, Urticaceæ, Scitamineæ, Dioscoreaceæ Palmeæ, Aroideæ, Cyperaceæ, Gramineæ.

The uses of the more important species, especially those of agricultura interest. Description and identification of weeds and noxious plants, examination and identification of seeds, botanical analysis of samples, examination and description of plants, dissection of typical specimens. Collection and preservation of plants.

Flowerless plants.—General description of algæ, fungi, lichens, mosses and ferns.

Diseases of plants.—Fungoid and other parasitic diseases, their nature, diagnosis, prevention and remedies, especially of agricultural plants, as rust, mildew, smut, bunt, coffee, blight, malformations.

Vegetable Physiology.—Experiments.

Practical.—Description and identification of plants, or parts of plants of agricultural or economic importance.

Subject III.—VETERINARY AND ENTOMOLOGY—(Two papers and two practicals).

1. VETERINARY—(One paper and a practical).

External Anatomy—of ox, of buffalo, of sheep and goat. Names of the different parts of the body as seen in living animals and their functions.

Internal Anatomy—

(*a*) The Skeleton—names and recognition of principal bones and joints of ox, buffalo, sheep.

(*b*) Muscles—diaphragm, biceps, serratus, masticatory, extensors and flexors of limbs.

(*c*) The various systems—Parts and functions of each of the following systems—digestive, urinary, lymphatic, respiratory, circulatory. Vessels at which the pulse can be taken in the ox, veins at which bleeding is performed.

(*d*) Skin, hair, horn, hoof.

Heat regulation of the body.

Eye anatomy.

Other senses.

Nervous system.

Animal heat and thermometry.

Birth, growth, development, decline, death and generation.

Practical work.—Recognition of the different organs of the body. Uses of clinical thermometers. Taking the pulse.

2. ENTOMOLOGY—(One paper and a practical).

Place in animal world, importance of Entomology.

External and internal anatomy of an insect.

Life history of insects.

Orders and main characteristics of principal orders with a brief description of insects of economic importance.

The food-plants.

General remedies.—Spraying, fumigating, sprays and spraying apparatus. More common pests of principal crops of the Presidency. How to recognise their work and remedies, parasites of animals.

Practical work.—Naming parts of an insect, classifying into orders; use of spraying apparatus. A collection of 100 specimens classified into orders should be handed in.

Subject IV.—AGRICULTURE—(One paper and a practical).

Supplying of plant-foods.—Plant-food forms assimilated, Nitrification. Manures; necessity for manuring; manure supply of India; classification.

Manures of animal origin.—Dung of different animals, relative and special values; urine; storage and preservation of manures; changes which they undergo; applications, quantity, frequency. Sewage and poudrette, treatment and value; fish manure. Bones, method of making their plant-food available; superphosphates.

Manures of vegetable origin —Oil-cakes, value, special uses; cotton seeds; ashes; leaf-mould; vegetable refuse.

Mineral manures.—Nitrates; potash salts; mineral phosphates; basic slag.

Manures which do not supply plant-food—Lime; salt; gypsum: their effect and application.

Rotation; mixed crops; leguminous crops; Nitrogen Bacteria and their culture.

Relation of manures to rainfall; manurial resources of India; conservation of manure; fixation of plant-food in soil; loss of manures by mismanagement.

Systems of manuring.

Practical work.—Ability to recognise different soils and manures, and to know their general composition and to apply them properly.

Each student should cultivate with his own hands not less than $\frac{1}{10}$th of an acre with two crops and should have this prepared for the inspection of the examiners.

Examination for the Diploma in Agriculture.

Subject I.—Chemistry of Agriculture—(One paper and a pratical examination).

(1) *The Soil. Origin of Soils*—Sedentary soils and soils of transport. Weathering. Composition of rock minerals and their weathered products. Soil and subsoil.

Mechanical analysis of Soils—Nature of soil constituents: Sand: Clay: Chalk and Humus. Methods of sampling soils. Mechanical analysis and interpretation of results.

Texture of the Soil—Meaning of; Pore space. Capacity for water. Surface tension and Capillarity. Percolation and Drainage.

Temperature of the soil.—Its origin. Variations in. Effect of colour, situation and exposure.

Chemical analysis of soils.—Methods adopted. Interpretation of results. Dormant and available plant food. Analysis of the soil by the plant. "Available" phosphoric acid and potash by use of weak acid solvents. Analyses of typical soils of India.

The living organisms of the soil.—Decay and humification of organic matter in soil. Fixation of free nitrogen by Bacteria. Fixation of Nitrogen by the soil.

Nitrification and Denitrification.

The power of the soil to absorb salts.

Retention of manures. Chemical and physical agencies at work.

The non-retention of nitrates. Composition of drainage waters.

Loss of nitrates by the land.

Causes of fertility and sterility of soils.—Drought, water-logging, presence of injurious salts. Alkali soils and Irrigation waters.

The amelioration of soils by liming, burning, etc.

(2) *The Plant.*—Elemental and general composition of plants. Organic part and ash.

Essential elements, source and supply available. Plant foods, forms in which assimilated.

(3) *Manures.*—as a source of plant food.

Chemical composition of manures:—

Organic manures.—Dung, urine, stable manure, sheep manure, poudrette, Guano.

Refuse products—Oilcakes, cotton-seed, bones.

Mineral manures—Form of plant food in each, and changes necessary before assimilation.

Relation of crop composition to analysis of soil and manure.

(4) *The animal.*—The constituents of the animal body. The processes of nutrition—food constituents, their special functions and relative value. Relation of food composition to different functions of animal life.

Waste products—relation of food to manure.

Practical Work.—Analysis of—

(1) *Soils.*—Mechanical analysis.

(2) *Manures.*—Moisture; organic matter, soluble and insoluble phosphates: Potash; and Nitrogen.

(3) *Fodders.*—Moisture, albuminoid and total nitrogen, oil, carbohydrates, mucilage, etc., woody fibre, ash and sand.

(4) *Milk.*—Use of lactometer. Specific gravity, estimation of total solids, fat, total albuminoids, ash, sugar (Fehling).

(5) *Butter.*—Estimation of water and fat. Detection of colouring matters and preservatives.

Subject II.—BOTANY—(One paper and a practical examination).

Natural orders, names, position and principal characters of the orders containing the chief agricultural and economic plants; the habits and uses of the more important species.

Arboriculture.—Names, descriptions and habits of the principal fruit, shelter, and timber trees, their cultivation, growth and propagation. Economic and sanitary uses and application.

Horticulture.—The culture of fibres, dye stuffs, tea, coffee, cinchona, cocoanut, arrowroot, spices; the preparation of these for market. The principal garden plants and vegetables of the Presidency, their cultivation, growth and propagation. The principles of grafting, layering and other methods of vegetative reproduction. Hybridization and cross-fertilization. Methods employed in the selection and improvement of economic plants.

Practical.—Recognition of specimens of plants of economic importance. Demonstration of one or more of the methods of vegetative reproduction, hybridization, cross-fertilization and selection.

Subject III.—VETERINARY—(One paper and a practical).

1. Hygiene—Sanitary location of the byres; drinking water, wholesome food; cleanliness.

2. Drugs—Classification of; simple remedies and their use; dose for animals of different age.

3. Medicine and surgery—Signs of health, and detection of ordinary signs of disease; how to make a simple *post mortem* examination, with an elementary record of results; names and detection of the principal external and internal diseases of ox, buffalo and sheep, especially constipation, indigestion, galls, hoven, colic, choking, sprain of the back sinews and treatment of principal Epizootics, their nature, causes, prevention and cure, especially rinderpest, surra, foot and mouth disease, tuberculosis, anthrax, contagious diseases of mange, ringworm, foot-rot. Principal diseases of young stock. Poisons and poisoning.

Wounds—First aid and antiseptic treatment, nursing. Castration; sterility, causes of and remedies for.

Obstetrics.—Normal parturition, its management, primary action in obstructive birth; inversion of the uterus, retention of placenta; abortion.

Administration of medicines to an ox, buffalo, sheep; how to throw an ox.

Practical work.

1. Recognition of simple drugs.
2. Administration of medicines to an ox.
3. Recognition and explanation of use of simple appliances.
4. Petty surgery.
5. Elementary diagnosis.
6. Distinction of diseased from healthy parts.
7. Detection of lameness.
8. Detection of when an ox needs shoeing or when he is badly shod.

(All questions in the practical will be based directly on the theoretical course).

Subject IV.—AGRICULTURE—(Two papers and a practical.)

Paper 1.

Crops.

Classification of crops of the Presidency, botanically, (1) according to season, (2) according to purpose, (3) according to feeding habits, and (4) according to soil requirements.

Cultivation of crops.—Soils adapted for, season, manure, requirements, tillage, seeding rate, average outturn, harvesting and preparation for market of farm crops. Management of pasture and grass land. Selection of seed.

Paper 2.

Animal husbandry.—Branches—Zoological classification of domestic animals.

Cattle, classification according to purpose; Indian cattle, types found in the Bombay Presidency, breed-descriptions, distribution, merits and defects of each; special dairy breeds; general description of European breads of neat cattle, purposes for which kept.

Buffalo breeds found in the Presidency, description, distribution, merits and defects.

Horses—Breeds found in India, merits and defects. General description of English breeds.

Sheep—types of Indian breeds, distribution, description, merits and defects.

Goat do. do. do.

Management and care of live-stock.—Stock breeding, principles of; general characteristics of good animals.

What is a breed? Objects of breeding, heredity, variation, fecundity in breeding, cross-breeding, grades, relative influence of parent, selection of animals for breeding, prepotency, care in management of breeding males, mating. Gestation, period in different animals. Care of pregnant females, management during parturition, treatment of very young animals, colostrum.

Housing.—Housing requirements for animals in India, situation, construction and drainage of cattle byres, location and construction of manure pits.

Feeds and Feeding.—Composition of food nutriments, purpose served by each nutrient, nutrient requirements for working, dairy and growing animals. Digestibility, conditions affecting; digestion co-efficient; classes of foods, nutrient ratio, rations, calories, feeding standards, cattle foods available in India, forage crops, proper harvesting and preserving to give the greatest feeding value, relative value of each. Making of rations from above substances, suitable for different purposes, seasons, and in accordance with ruling prices.

General management.—Time of feeding, water supply, cleanliness, dairy husbandry; *milk*, nature, general composition; comparison of the milk of Indian cows, buffaloes, European cow and goat. Conditions exerting an influence on the quality and quantity of milk; conditions to produce wholesome milk; individuality among dairy animals; contamination of milk; sources of, and prevention; treatment of milk; milking; cooling, pasteurising, sterilizing, marketing, care of milk vessels.

Cream.—Composition; separators.

Butter.—Making, churning, washing, salting, preserving, preparing for market.

Sheep husbandry.—Present customs, improvement.

Practical work.—This should include study of growing crops and ability to estimate probable outturn and give anna valuations.

The management of one acre plot by each student with duly filled cultivation sheet, balance sheet and diary of operations.

Ability to determine breeds—Scrutinize merits and defects of individual animals.

Practical dairy work.—Management of live-stock; showing a diary, recording the feed, work or milk of the animals given.

The agricultural tour should form an important part in practical agriculture and notes taken on these excursions should be presented to the Examiners.

UNITED PROVINCES OF AGRA AND OUDH.

The following course of studies is in force at the Agricultural School at Cawnpore.

"The course is intended to meet the requirements of students of the following classes:—

(1) Candidates for kanungoships.

(2) Candidates for employment under Government in the agricultural or other departments.

(3) Landholders, and students who propose to follow the profession of land-agent.

(4) Students who desire to follow agriculture, or horticulture, as a means of livelihood.

2. Candidates for Government service are required to have passed the Entrance, School Final, or some higher examination; and candidates for kanungoships are admitted only on the nomination of a District Officer serving in the United Provinces.

No examinational qualification is prescribed for students who are not candidates for Government service, but before admission they must satisfy the Principal that they know enough English to follow the teaching.

3. Students are required to reside in the boarding-house, or in such other place as may be approved by the Principal; and all students are required to receive regular instruction in gymnastics and to participate in the school games so far as their physique permits.

4. No fees are charged at present, but students are required to subscribe to the various school clubs in whose benefits they share.

5. The course of study is divided into two sections: the first or general section extends over about twenty months (inclusive of vacations), and must be taken by all students; the second section consists of various special courses of varying length, one of which must be taken by each student.

6. The subjects taught in the first or general section are:—

(1) The theory and practice of agriculture (including the care and treatment of farm animals and farm book-keeping).

(2) The elements of the following branches of science so far as they are required for a proper understanding of the agricultural course:—(*a*) Chemistry, (*b*) Botany, (*c*) Physics and Mechanics, (*d*) Physiography, with the geology of alluvium.

(3) The elements of surveying and practical mensuration: the land record and tenancy systems of the Provinces; and estate accounts.

(4) Riding is taught to all kanungo candidates: it is optional for other students.

(5) Kanungo candidates are tested from time to time in their knowledge of Hindu and Urdu, and special instruction is given to those who are deficient in these subjects.

7. The special courses at present arranged are as follows; endeavours will be made to arrange other courses to meet the needs of individual students:—

(1) *Kanungo's work.*—This is compulsory for all kanungo candidates, and includes further instruction in surveying and in the preparation and supervision of the land records.

(2) *Estate management.*—Arrangements are made to post students as apprentices in large estate offices, where they will obtain a practical insight into the fixing and collecting of rents, the system of accounts, and the general management of an estate.

(3) *Farming.*—Students will be attached to one of the Departmental farms for further practical work.

(4) *Horticulture.*—Students will be attached to one of the Government gardens for a practical course.

(5) *Agricultural work.*—Students who wish to enter the Agricultural Department will be placed on the staff of one of the expert officers, under whose orders they will work; and those who show themselves suitable will have a preference for Departmental appointments.

8. Students who qualify in the general section and who show diligence and aptitude in one of the special courses will receive the diploma of the school."

No course of studies has yet been framed for the proposed Agricultural College, but it is intended to follow the same lines, say 30 months of the general course and about six months of the special courses. The extra time in the general course is required partly to give a wider and deeper foundation of

science, than is possible at present and partly to go further in the theory and practice of agriculture.

The bifurcation into special courses will, I venture to think, be found necessary in all colleges where the students will be trained to meet such diverse needs as is the case at Cawnpore. It may be suggested that these special courses should follow the college course and be independent of it; the present objection to this is that it will not be possible to keep the bulk of the students for more than three years in all; while special training after the college course is over may degenerate into loafing. By the plan outlined in the course of studies, the diploma depends on due diligence during the special as well as the general course.

As regards the subjects mentioned in paragraph 6, it will be seen that entomology and mycology are not mentioned. The practical side of entomology, the combat with insect pests, is included in the agricultural course, while fungoid diseases are dealt with under botany.

It is a question whether these two sciences should appear as such in the college course. I am inclined to think they are not really needed, and that they would require more time than can be found if they are to be more than a smattering

The college course will include the elements of geology, not merely the geology of alluvium, to which practical considerations limit the school course at present.

The third group of subjects in the present course will be expanded so as to cover the field of Agricultural Economics: *i. e.*, the study of the environment of the cultivator, economic, social and legislative.

As regards the co-ordination with Pusa, I have always contemplated that for students who desire to go on to Pusa the special course would consist of individual tuition in any branches of agricultural science in which the Pusa scheme requires greater proficiency than is needed in the case of ordinary students.

I venture to suggest that the Board should, even at this early stage, consider the nature of the titles to be given to students of Pusa and of the colleges. The people of these provinces (and possibly elsewhere) attach the greatest importance to the right of attaching letters to one's name and in order to assist recruiting it is highly desirable that when the colleges open they should be empowered to offer the prospect of a definite title or degree.

For the colleges, I suggest that the word "bachelor" should be avoided, while "diplomist" or "diplomate" when abbreviated is liable to confusion with "doctor." "Licentiate in Agricultural Science" (L. A. S.) would probably be found convenient. Pusa could in time confer the higher degrees of M. A. S. and D. A. S. (W. H. Moreland.)

Central Provinces.

Syllabus of Studies, Agricultural School, Nagpur.

A.—Agriculture.

Soils (*First year.*)—Origin of soils; soils *in situ* and alluvial soils; description of principal soils of the Central Provinces, with names and qualities; classification of soils by mechanical analysis; fertility of soils as dependent on composition, texture, depth and lie of surface; effect of climate in improving soils; improvement of soils by levelling and by embankment; cost of these processes.

(*Second year.*)—Physical properties of soils; their absorbent and evaporative powers; capillary action; chemical composition of soils considered with reference to supply of the more important plant food elements; the use and abuse of soil analysis; soil analysis by cropping (Ville's method); dormant and active condition of plant food elements; effect of climate and of tillage in converting plant food from the dormant to the active condition; loss of plant food by surface scouring; the exhaustion of soils; its signs and its causes; uses and methods of fallowing; rotation of crops.

Tillage (*First year*).—Objects to be attained; influence of climate in assisting and obstructing tillage; use of a fine tilth; the conditions in which

different soils are suitable for sowing ; different systems of tillage instanced by the systems followed for wheat, for *juari*, for sugar-cane and for rice; implements used for tillage ; the *nagar* in its different forms, *bakhar*, the clod crusher, English ploughs and harrows.

(*Second year.*)—The history of the plough ; the theory and method of adjusting the English plough ; the materials used for various implements and the method of their construction ; special operations of tillage for breaking up waste land or eradicating grass ; the advantages and dangers of deep ploughing ; the effect of embanking land in lessening the need of tillage, the cost of the various operarions of tillage.

SOWING (*First year.*)—The condition in which land is fit for sowing; methods of sowing practised with different crops; the *nari* plough ; *tifans*, the *argara* ; broadcast sowing ; the depths to which different seeds should be sown ; thick and thin sowing ; English drills ; the growth of seedlings for transplantation ; the advantages of transplanting.

(*Second year.*)—The vitality of seeds and means of ascertaining whether seed has retained its vitality or not ; special preparation of seed for sowing ; use of sulphuric acid for cotton ; pickling seed ; improvement of seed by special cultivation and selection ; the principles to be followed in selecting seed, the use of changing seed : special treatments in preparing seed beds for the growth of seedlings for transplantation ; cost of sowing and transplanting.

MANURE (*First year.*)—The need of applying manures; exhaustion of soils by continuous cropping ; soils which give and do not give good returns for manuring ; descriptions of manure used by the people and the method of their application ; cattle dung, the best method of storing it ; the condition in which it should be applied ; the seasons for its application ; green soiling ; bones, the manufacture of bone meal ; saltpetre ; town sewage.

(*Second year.*)—Manures considered in relation to plant food ; the particular plant food supplied by different manures ; suiting the manures to the requirements of the soil ; the changes occurring in manure pits and the means of regulating them so as to prevent loss of value ; the method of making bone superphosphate ; the theory of green soiling and of growing crops in a mixture ; use of slaked and unslaked lime and gypsum : the various methods of utilizing town sewage in agriculture ; the cost of various manures and of applying them.

IRRIGATION (*First year*).—The crops for which irrigation is needed ; monsoon irrigation of rice ; cold weather irrigation of wheat, vegetables and sugar-cane ; different methods of lifting water : the well bucket, the Persian wheel, the lever life, the swing bucket, pumps ; kacha and packa wells ; the means of irrigating from streams and nallas ; the irrigation of rice and sugar-cane from tanks.

(*Second year*).—The extent to which water enters into the composition of plants ; use of water as a carrier of plant food ; sources from which plants derive their water-supply ; the rainfall ; the retention of moisture by different soils ; the depths from which plants can draw sub-soil moisture ; the circumstances which render irrigation necessary ; its use in distributing the supply from rainfall rather than in adding to it, the method of constructing different water lifts and their cost ; the construction of pucka and kacha wells ; the method of lining kacha wells ; the places favourable for well construction ; the construction of tanks and the places favourable for their construction ; the methods of roughly testing discharges and ascertaining the efficiency of different means of lifting water ; surface and under-ground drainage, natural and artificial.

PROCESSES INTERMEDIATE BETWEEN SOWING AND REAPING (*First year*).—Weeding ; the names and characters of the principal weeds ; the injury which weeds cause to crops ; the importance of not permitting weeds to seed ; weeding by hand and by bullock power ; the *daura* and *dundia* ; cost of weeding ; saving of weeding by good tillage ; importance of keeping the ground open round the roots of growing plants in order to check evaporation.

(*Second year.*)—Increasing the yield of crops by checking their growth ; topping cotton ; the " beasi " of Chattisgarh ; watching crops ; methods of scaring animals ; cost of watching ; chief methods of fencing ; means of trapping noxious animals.

GATHERING AND CLEANING (*First year*).—The harvesting of *juari, til,* wheat and linseed; the means of threshing and cleaning them used by the people contrasted with threshing and winnowing machines; the importance of proper cleaning; the meaning of "refraction" in trade.

(*Second year.*)—The harvesting of rice, cotton, sugar-cane and tobacco; rice cleaning, cotton ginning, sugar boiling, and tobacco curing; the manufacture of drained sugar.

GENERAL (*First year.*)—The Indian seasons and the crops which grow in them; the effect of heat and cold, moisture, drought and cloudy weather on different crops; crop diseases; rust, ergot and caterpillars.

(*Second year*).—The principal crops grown in the Central Provinces; the habits of growth of their roots and stems and their effects in cleaning land, enriching or impoverishing it; the amount of each principal plant food contained in a crop of wheat, and the sources from which it obtains these foods; the part played by the atmosphere in the nutrition of plants; carbonic acid, its presence in the air and its fixation by plants; the ammonia received by the soil in rain; Nessler's tests; nature of fungoid disease as shown by the microscope.

CULTIVATION OF SPECIAL CROPS.—Students will be practically taught to grow and prepare for market the following crops:—

(*First year.*)—*Juari, til,* wheat and linseed.

(*Second year.*)—Cotton, rice, sugar-cane, tobacco and garden crops.

FEEDING AND CARE OF STOCK (*First year*).—The food to be given to cattle in work and out of work; importance of a mixed diet; advantage of giving salt; injury resulting from sudden change from dry to green food; the comparative advantages of grazing and stall feeding; the growth of fodder crops, *popat, lakhori,* guinea grass.

(*Second year.*)—The chief breeds of cattle found in the Central Provinces; the best methods of housing cattle and preserving their manure; the use of the chaff cutter; ensilage; the comparative merits of cotton seed, *karbi,* wheat straw, rice straw and pulses as cattle food; the influence of these foods on the value of cattle dung as manure.

FRUIT GROWING (*First year.*)—The methods of sowing and transplanting mangoes, oranges, plantains and guavas.

(*Second year.*)—Grafting and budding.

B.—ELEMENTARY CHEMISTRY.

(*First year.*)—Changes occurring in air during the burning of a candle; chemical action; indestructibility of matter: elements and compounds; resolution and formation of compounds by analysis and synthesis; metals and non-metals; water; its decomposition by electricity into oxygen and hydrogen; other methods of preparing oxygen and hydrogen; properties of oxygen and hydrogen; ozone, its formation and properties; determination of the composition of water by volume and weight; three physical states of water; ice, steam, change of state produced by heat; expansion of bodies by heat; thermometers; maximum density of water; latent heat of water; evaporation; weight of water; specific gravity; compressibility of water; Florentine experiment; porosity of matter; purity of water; hard and soft water; filtration and distillation; water of crystallization; solvent property of water; liquid diffusion; dialysis; osmose; air; chemical composition of air; difference between simple mixture and chemical compound; eudiometer; preparation and properties of nitrogen; functions played by the several constituents of air in the economy of nature; action produced by animals and plants on air; weight of air; barometer; air-pump; combustion; carbon, its varieties and properties; structure of flame; blow-pipe; reducing and oxydising flame; preparation of coal gas; Davy's safety lamp; preparation and properties of nitric acid; ammonia and carbon dioxide; chlorine, its preparation and properties; preparation and properties of hydrochloric acid; aqua regia; bleaching powder and its uses; occurrence, modifications and properties of sulphur; silicon, its occurrence and properties; occurrence, preparation, modifications and properties of phosphorus; occurrence and properties of zinc, tin, lead, copper, mercury, silver, gold and platinum.

Practical.—Solution and filtration ; preparation of hydrogen, oxygen, ammonia, carbon dioxide and nitric acid ; mechanical analysis of soil ; detection of lime in soil ; and chemical analysis of simple salts containing the following basic and acid radicles :—

Basic radicles—Lead, silver, mercury, bismuth, copper, cadmium, arsenic, antimony, iron, aluminium, chromium, nickel, cobalt, manganese, zinc.

Acid radicles—Sulphuric, carbonic, nitric, hydrochloric.

(*Second year.*)—Atom and molecule ; atomic weight ; laws of combination ; nomenclature, symbolic notation and formulæ ; nature of acids, bases and salts ; preparation and properties of sulphuric acid and hydrogen sulphide ; silica, its occurrence and properties ; tribasic phosphoric acid ; its preparation and properties ; preparation and properties of potassium; caustic potash; potassium carbonate ; potassium nitrate ; composition of gunpowder; composition of soap ; sodium; caustic soda; sodium chloride ; sodium carbonate ; sodium nitrate ; sodium sulphate ; ammonium ; ammonium chloride, carbonate, nitrate and sulphate ; calcium ; caustic and slaked lime; calcium carbonate, sulphate and chloride ; aluminium ; alumina ; aluminium sulphate ; formation of clay ; composition of glass, porcelain and earthenware ; magnesium; magnesia ; magnesium sulphate ; manganese ; black oxide of manganese ; iron, manufacture of wrought iron, cast iron, and steel ; ferrous sulphate and sulphide ; ferric sulphate ; carbohydrates ; cane sugar ; grape sugar ; starch and woody fibre ; albuminous substances ; fibrin ; casein ; glutin and gelatin ; composition of bone, blood, saliva, gastric juice, bile, milk and urine.

Practical.—Chemical analysis of simple salts, containing the following basic and acid radicles and a few mixtures of the above salts :—

Basic radicles—Barium, strontium, calcium, magnesium, potassium, sodium, ammonium.

Acid radicles—Sulphuric, carbonic, silicic, phosphoric, hydrochloric nitric.

Manufacture of superphosphate ; detection of organic acids in soils ; detection and distinguishing of starch and sugar ; detection of phosphates, potassium compounds and calcium compounds in soil and ashes of plants.

C.—Elementary Geology.

(*First year.*)—Object of geology ; crust of the earth ; materials of which the crust is made ; definition of rock and mineral ; three great classes of rocks, (1) sedimentary (including organically formed), (2) igneous and (3) metamorphic : description of typical specimens of the different classes of rocks ; sandstone, chalk, granite, gneiss ; origin and mode of formation of the different classes of rocks ; change producing agencies ; atmospheric agencies ; action of carbon dioxide, oxygen, moisture, frost and winds ; formation of soil *in situ* ; aqueous agencies ; action of streams, rivers, springs, seas and ice action ; organic agencies, coral zoöphytes, shell-fish, foraminifera ; peat mosses, etc. ; formation of coal ; igneous agencies ; interior of the earth ; hot springs, volcanoes, earthquakes and slow movements of the crust ; fossils and fossilization ; uses of fossils in geology ; general characters of minerals of common occurrence, quartz, chalcedony, jasper, agate, flint, felspar, hornblende, zeolite, mica, calcite, gypsum, apatite, fluorspar, rock-salt.

(*Second year.*)—Structure of rocks, stratified, oolitic, crystalline, glassy, porphyritic, vesicular, amygdaloidal, schistose ; arrangement of rocks, stratification, ripple marks and rain prints, conformable and unconformable strata, dip, strike, out-crop, anticline and syncline, faults, metamorphism, bosses, intrusive and interstratified sheets, veins and dykes ; mineral veins, characteristics of different kinds of rocks, sandstone, grit, conglomerate, shale, limestone, dolomite, gypsum, rock-salt, iron stone, shell marl, coral rock, chalk, peat, lignite, coal, graphite, anthracite bombs, volcanic, ash, lava, obsidian, pumice, trachyte, granite, basalt, laterite, slate, mica-schist, gneiss, marble ; succession of strata ; relative age of rocks, tests for determining the relative age of rocks ;

geological divisions, azoic, palaeozoic, mesozoic, neozoic ; nebular hypothesis ; azoic rocks and their occurrence in India, composition, distribution, economic products and characteristic fossils of the formations of stratified rocks ; silurian, devonian, carboniferous, permian, triassic, oolitic, cretaceous, tertiary and recent ; principal formations of Peninsular India, Gondwana, jurassic, cretaceous, Deccan trap, tertiary, post tetiary.

Practical.—Identification of the rocks and minerals of common occurrence, and a general knowledge of the Geology of Nagpur, based on Hislop's account of it.

D.—Elementary Botany.

(*First year.*)—General characters of flowering plants ; structure of a typical plant ; organs of nutrition and reproduction ; characters of roots, stems, leaves ; root fibres and root hairs ; true and adventitious roots ; aerial roots ; forms of roots ; parasites and epiphytes ; buds ; forms of stems ; tendril ; spine ; prickle ; parts of leaf ; duration, arrangement, outlines, margin and surface of leaves ; venation ; simple and compound leaves ; vernation ; inflorescence ; bracts ; involucre ; receptacle ; floral whorls ; insertion, adhesion, and cohesion of parts of floral whorls ; suppression and multiplication of parts ; aestivation ; placentation ; description of specimens of plants ; functions of root, stem, leaves, flower ; fertilization ; crossing ; classification ; species, genera, orders and classes ; primary division of plants, flowering and flowerless ; distinguishing characters of dicotyledons and monocotyledons ; structure of plants of the following Natural Orders ; Leguminosæ, Malvaceæ, Cucurbitaceæ.

(*Second year.*)—The fruit and its parts ; dehiscence of fruits ; classification of fruits ; structure of different kinds of fruits, legume, drupe, capsule, berry, achene, nut ; the formation and development of the following fruits : orange, guava, mulberry, fig, cotton pod, cucumber, pea, mango, cocoanut ; the seed and its parts ; germination of seeds : conditions essential for germination ; surface coverings and appendages ; cells, their forms, structure, composition and contents ; growth by division of cells ; tissues of plants, parenchyma, epidermis, wood, bast and vascular tissues : latex vessels ; fibro-vascular bundles ; internal structure of root, stem, leaves ; arrangement of tissues of stem in dicotyledons and monocotyledons ; food of plants ; conditions of plant growth ; selection and absorption of food and storing of nutriment ; ascent of the crude sap ; respiration, transpiration, assimilation ; descent of sap ; influence of light and heat on plants ; origin of species ; structure of plants of the following Natural Orders : Compositæ, Cruciferæ, Myrtaceæ, Urticaceæ, Graminæ.

E.—Land Surveying.

(*First year.*)—Plotting to scale ; map drawing and colouring and the use of conventional signs ; chain surveying by triangles and by sight rule ; survey by intersection ; calculation of areas by mensuration and by acre comb.

(*Second year.*)—Use of the theodolite and chain in traversing ; traversing with the sight rule and protractor ; Gale's method of plotting a traverse ; proving a traverse and calculation of areas by universal theorem ; use of the planimeter, proportional compasses and pentagraph.

F.—Drawing.

(*First year.*)—Free hand.

(*Second year.*)—Model.

G.—Veterinary Science.

Firs year (Junior class) students.

Anatomy.—The main anatomical parts, and the practical names given to them by Veterinarians. The age of bullocks. The names of important joints. Contents of the thorax, abdomen and pelvis, with their names and positions. The different parts of the feet of a bullock. Practical dissection.

Physiology.—The function of important organs in the chest and abdomen, and of the urinary organs. Respiration, circulation and the process of digestion.

Practical demonstration—Handling and Casting animals.—Methods of throwing bullocks, the names and uses of the veterinary appliances at the hospital, and the uses of simple surgical instruments including the clinical thermometer and catheters. Castrating instruments. The feeding, management and general keep of cattle.

The dressing of wounds and ulcers, and treatment of ordinary cases attending the hospital.

Materia Medica and Pharmacy.—The method of making up and administering drenches, balls. Making infusions, decoctions, powders, ointments and liniments. The names, uses and doses of the principal medicines, both English and Country, with their actions, such as narcotics, diuretics, astringents, purgatives, diaphoretics, disinfectants, stimulants, sedatives and tonics. Botanical names of plants forming some of the above with ocular demonstration, if possible.

Second year (Senior class) students.

(1) The four deadly forms of cattle-disease, with their chief symptoms and medicinal treatment. Sanitary measures for the suppression and prevention of these diseases.
(2) Minor diseases of cattle, with chief symptoms and their treatment.
(3) Treatment of ordinary forms of wounds, broken horn and ulcers.
(4) Post-mortem examination.
(5) The popular method of castration, with practical illustrations, and the principles of cattle-breeding.
(6) Lameness, sprains, shoulder slip, etc., with the names of the diseases of main joints and their treatment.
(7) Surgical operations, *viz.*, opening abscesses, removing tumours, tapping the abdomen for hoven, etc., blood-letting.

APPENDIX I.

Note showing the action taken on the Proceedings of the First Meeting of the Board of Agriculture in India.

This note has been prepared, for the information of the members of the Board of Agriculture, to show the action taken on the recommendations made at the first meeting of the Board of Agriculture. The references are to the numbered paragraphs of the Proceedings of that meeting, those in which no action was necessary being omitted.

Item 2.—A programme of experiments with *Indigofera arrecta* and *Indigofera sumatrana* was drawn up by the Director of the Agricultural Research Institute, Pusa, in consultation with Mr. Bergtheil, with the following objects—(1) to ascertain whether it was desirable to grow *I. arrecta* under irrigation; (2) to ascertain the best sowing season for this variety; (3) to ascertain the colouring contents of different species of indigo plants; (4) selection of plants of *I. arrecta* for thinness of seed coat; (5) to ascertain the best distance for sowing *I. arrecta*; (6) to ascertain the effect of "topping" plants; and (7) selection of seed of both varieties for the improvement of colouring matter and seed. The experiments have shown that so far the Java plant is very superior to the Sumatra, possessing a higher percentage of leaf and of potential colouring matter in the leaf. Experiments in hybridization were postponed until the arrival of the Biological Botanist.

Item 3.—The expert officers of the Imperial Department of Agriculture, the provincial Directors of Agriculture, the Superintendent of the Royal Botanic Garden, Calcutta, Dr. Lehmann, and Dr. Mann were requested to offer suggestions to assist in framing the scheme of experiments for the Pusa farm. Some valuable proposals have been received, which are dealt with in the programme submitted by the Director.

Item 4.—Dr. Leather offered to provide Madras with temporary assistance in chemical analysis to determine the time necessary for the full ripening of sugarcane. To suit the convenience of the local authorities it was arranged to postpone the deputation of an assistant till 1906.

Item 5.—Dr. Butler visited several places in Assam during the month of May 1905 for the investigation of the potato blight. He carried out spraying experiments for potato blight at the Shillong Fruit Garden; he also observed and investigated, where possible, strawberry bright, peach leaf-curl, vine mildew, raspberry blight, beetle palm, agave, and coffee diseases. In the first week of August he visited Maldah (Bengal) and ascertained that the cause of the mango disease was the Alga (*Cephaleuros virescens*) commonly known as red rust when it attacks tea. Dr Butler has promised to make a separate report after some necessary laboratory work.

Item 6.—Experiments in the trial of rust-resistant wheats have been arranged at the Hoshangabad Farm (Central Provinces) and the Lyallpur Farm (Punjab), in accordance with a detailed plan framed by the Cryptogamic Botanist.

Item 7.—The Government Entomologist made a tour in Assam in May 1905, for the investigation of local insect pests and visited the Upper Shillong Farm, the Shillong Fruit Garden, and the Wahjain Tropical Plantation. He observed the common green bug in potato plants in the Upper Shillong Farm; grubs attacking pear and apple, and small chafer beetles attacking white flowers, in the fruit garden; and mealy bug in the orange grove of Wahjain Plantation. He also tried and suggested remedies where possible. He also suggested improvements in the apiculture experiments carried on at the Shillong Farm; examined various insect groups in the Khasia Hills; started a survey of the insect pests of Assam Valley; and investigated the life-history of the *gad* flies, attacking men and animals.

Item 9.—In accordance with the Board's recommendation that a plot for experiments with the wilt disease of *tuer* (Pigeon pea) should be added at one of the Poona Farms, the Director of Agriculture, Bombay, selected a plot which had grown diseased *tuer* (*Cajanus Indicus*) in the previous year

and arranged to grow varieties of *tuer* in it and to watch their behaviour in regard to resisting the disease and to continue the experiments in the same plot without rotations till a definite result was obtained.

Item 11.—The Board considered that the experiments in tobacco-curing in Madras were not likely to lead to any useful results until they are placed under the guidance of an expert and a chemist. In March 1905, the Inspector-General of Agriculture visited Madras and made some inquiries into the tobacco problem of that presidency. He reported that there was ample room for investigation by an expert, and in view of similar needs in Bengal, which is a prominent tobacco-growing province, as well as of other presidencies, the Government of India have recommended the appointment of a tobacco expert on the Imperial staff, who will be qualified to guide experiments in the improvement of methods of curing. As it is hoped that each important province will employ an Agricultural Chemist, it was not considered necessary to employ a separate chemist for tobacco in addition to an expert in the curing processes.

Item 13.—In February 1905 the Inspector-General of Agriculture toured in Burma with the object of assisting the Local Government to formulate proposals for giving effect to the recommendation of the Board for the organization of a local department of agriculture and framed a scheme for the consideration of the Local Government. The proposals of the Local Government for the organization of an agricultural department have been approved and a grant has been given out of the Rs. 20 lakhs set apart by the Government of India for the expansion of provincial departments of agriculture.

Item 14.—The Board recommended the expansion of the agricultural department to provide supervision by expert officers in the Central Provinces. Effect has been given to this recommendation in the scheme framed for the expansion of the Provincial Department of Agriculture.

Item 15.—In accordance with the Board's recommendation a scheme has been framed for the expansion of the Assam Agricultural Department, which covers work in the important cultivated plains.

Item 21.—The Board recommended experiments with a view to the extension of jute cultivation in suitable tracts outside Bengal, particularly in the Godaveri Delta of Madras. The Inspector-General of Agriculture supplied the Madras and the Central Provinces Departments with selected seed of jute of six varieties for experimental trial in the Godaveri Delta (Madras) and Chhattisgarh Division (Central Provinces), together with instructions for the cultivation of the crop. The Departments of Agriculture of Madras and Central Provinces have started the experiments. The first trial in the Central Provinces has not been very promising, due to late sowing, excessive watering and other mistakes in cultivation. The Inspector-General of Agriculture has drawn the attention of the local Department of Agriculture to the mistakes, and has recommended the employment of an experienced jute cultivator from Bengal.

Mr. R. S. Finlow, B.Sc., Jute expert to the Bengal Government, has arranged to visit Madras, Central Provinces and Bombay to examine the suitability of some tracts for the trial of jute and to assist the local departments with his advice.

Items 22.—The Board recommended that the services of an expert for the investigation into the cultivation, chemistry and other problems connected with jute should be secured. The Bengal Government recommended the creation of a permanent post of Jute and Indigo Expert and Mr. R. S. Finlow's appointment to it. The Government of India have referred this proposal to His Majesty's Secretary of State for orders.

Items 23 *to* 27.—The recommendations of the Board in regard to irrigation experiments were referred by the Government of India to Local Governments who were asked to issue such orders as they considered advisable.

Items 28 *to* 30.—The recommendations of the Board in regard to veterinary matters were referred to the Local Governments by the Government of India for such action as they considered advisable.

Item 31.—*Extension and Improvement of Indian cotton.*—The Board placed on record its sense of the danger attending on the recommendation to cultivators of the trial of varieties which have not been properly tested. The

Government of India asked Local Governments to issue such orders as they considered advisable.

Item 33.—The Director of Agriculture, Bombay, requested the Commissioner in Sind to publish a warning that the cultivation of Egyptian cotton in Sind must at the present stage be regarded as experimental. In November last the Inspector-General of Agriculture visited Sind and submitted to the Government of India a note on the experiments with Egyptian cotton. He found that the results, so far as they are known, of the year's trials are very promising. There are only two years' crops from which to draw conclusions, but unless something unexpected happens there is great promise that Egyptian cotton may be grown on an extended scale in Sind. It has yet to be seen whether the staple will deteriorate from year to year by continuous cultivation, or whether the first year's deterioration is merely temporary and due to the changed conditions of climate and soil, from which the plant will soon recover. The apparent normal growth of the plants raises the hope that the latter is the case. Again, further experiment is required to decide which is the best variety of Egyptian cotton for general cultivation. This year's trial points to *Abassi*. It has been decided for the present to proceed slowly as the cultivator requires to be instructed and supervised. A leaflet describing the methods of cultivation has been prepared by Mr. Fletcher; but it is necessary to see that the cultivators carry out the instructions. It was decided to increase the area under Egyptian cotton from 1,500 to 5,000 acres during the coming year.

Item 34.—With reference to the recommendation of the Board for the programme of cotton experiments in the United Provinces, the Director consulted the Inspector-General of Agriculture upon the programme of cotton experiments for 1905 which included (1) hybridization, (2) selection of seed of the indigenous variety mainly for the purpose of improvement of yield, and (3) the trial of the *bani* variety of cotton. He also submitted a note on the attempts made in the past in the direction of the improvement of cotton in the United Provinces. The Inspector-General of Agriculture suggested that it would be better to conduct the hybridization experiments on the Government farms in the cotton tracts instead of confining them to Saharanpur, which is entirely outside the cotton country. He also urged the necessity of laying down a definite plan of experiments in hybridization.

Item 35.—The Board recommended that the operations connected with the experimental cultivation of cotton in Madras should be extended to the two cotton-growing districts of Coimbatore and Kristna. This has been provided for in the scheme for the expansion of the Madras Department.

Item 42.—The Government of India asked the Inspector-General of Agriculture to submit the recommendations of the Board on the memorial of the British Cotton Growing Association separately with his remarks. The Government of India have recommended to the Secretary of State the appointment of a cotton expert on the staff of the Imperial Department of Agriculture and have requested the Secretary of State to select a suitable candidate possessing a sound education in scientific agriculture combined with a knowledge of the methods of cotton cultivation practised in America or Egypt (preferably both), together with an acquaintance with the recent work of the Agricultural Departments of those countries.

The Government of India agreed with the Board that whilst it is inexpedient to create a separate Cotton Department distinct from the Department of Agriculture, the number of experts in all provinces should be strengthened, so that a competent scientific staff may be employed, not only for the improvement of cotton, but for the investigation of the many other agricultural problems of India. This has been provided for in the schemes for the expansion of the provincial departments. After consulting Local Governments, it was decided to defer the establishment of large Cotton Seed Farms, but it was agreed to establish experimental *farms in all important cotton tracts and to* add to each a substantial area for the production of selected seed. The botanical survey of Indian cottons has, for the present, been completed by Professor Gammie, and his monograph is now in the press. In the other matters raised in the memorial of the British Cotton Growing Association, the Government of India adopted the advice given by the Board.

Item 43—*Publication of Experimental Farm Reports and Bulletins by the Provincial Departments of Agriculture.*—The Inspector-General of Agriculture made the following recommendations to the Government of India :—

(1) That the Report dealing with the administration of each farm should be incorporated in the report of the Director of Land Records and Agriculture in each Province. This report would, in addition to administrative details, contain information regarding the general line of experiments being carried out and their progress, together with an account of any positive action taken to make the farm and its teachings generally known to agriculturists.

(2) That for each farm a continuous record of experimental results should be maintained. This record would be printed annually in octavo form and distributed among the agricultural departments generally and to persons interested in experimental work.

(3) That when a series of experiments has become sufficiently advanced to yield definite results, a separate bulletin containing an account of the experiments and the results achieved should be published for general information.

The Government of India referred the above proposals to the Local Governments for opinion. The replies of the Local Governments have been received and they are at present under the consideration of the Government of India. The recommendations have, with a few small exceptions, met with general approval.

Items 44 *and* 45.—*Publication of Agricultural Journal and Memoirs.*—With reference to these recommendations of the Board, the Inspector-General of Agriculture submitted to the Government of India proposals for the issue of an Agricultural Journal and Scientific Memoirs by the Imperial Department of Agriculture. The Government of India have sanctioned the proposals tentatively for a period of three years in the first instance. The Inspector-General of Agriculture has been appointed Editor, with the assistance of an Advisory Committee of the Pusa staff of experts.

Item 46.—*Suggestions to bring the imperial experts into closer touch with the provincial departments of agriculture.*—The Government of India referred the recommendation regarding inter-communication between imperial and provincial experts and between the latter, to Local Governments and asked them how far they were prepared to accept the arrangements suggested by the Board and what modifications, if any, they wished to propose. The recommendations met with general acceptance, some modifications being made by a few provinces.

Item 47.—*Training of provincial assistants in special branches of Agricultural Science.*—The Government of India asked the Inspector-General of Agriculture to submit definite proposals on this subject to the Local Governments. A scheme was accordingly framed for the training of provincial assistants at Pusa, pending the opening of the Pusa College, in (*a*) Agriculture, (*b*) Chemistry, (*c*) Mycology, and (*d*) Entomology. The Provincial Directors propose to send the following candidates to Pusa for training :—

Serial No.	Province	Date on which candidates are required to be at Pusa.			
		As soon as possible.	1st December 1905.	1st October 1905.	February 1906.
		General Agricultural.	Agricultural Chemistry.	Mycology.	Entomology.
1	Bengal	...	1	1	...
2	Madras	...	1	...	1
3	Punjab	...	...	...	...
4	Eastern Bengal and Assam	2	...	...	...
5	United Provinces	...	...	1	1
6	Central Provinces	1	1	1	...
7	Baroda	...	...	...	1

Item 48.—*Provision of rest-houses at Experimental Farms.*—The Government of India asked the Local Governments to issue such orders as they considered to be advisable.

Item 49.—The Board recommended a lending department in the library of the Pusa Institute. This subject was fully discussed with the members of the Pusa staff and a set of rules for the management of the library and reading-room, which also includes rules for the lending department, has been framed, of which a copy is attached. The preparation of the library catalogue is in progress, and when this is ready the lending department will be opened.

Items 50 *to* 58.—The recommendations of the Board, for bringing provincial departments into closer touch with agriculturists, were referred by the Government of India to Local Governments for the issue of such orders as are considered to be necessary.

Item 59.—*Education in Rural Schools.*—With reference to the Board's recommendation, the Inspector-General of Agriculture submitted to the Government of India the following proposals on the subject of Agricultural Education in rural schools:—(1) That a closer connection should be established between the Education and Agriculture Departments in the control of rural education; (2) that the Director of Agriculture should be a member of the Text-Book Committee appointed to revise the curriculum and text-books of rural schools; (3) that the Provincial Directors of Agriculture should submit the revised text-books to the Imperial Department of Agriculture before their final adoption so that they might have an opportunity to advise upon them. These proposals were circulated to all Provincial Directors of Public Instruction. The Inspector-General of Agriculture attended the Educational Conference held at Simla in September last, where he read a paper on the "Education in Indian Rural Schools—a plea for Nature Study."

Item 62.—The Board recommended relaxation of the rules regarding direct purchase of scientific apparatus and stores by the departments of agriculture. The question was considered by the Government of India, who communicated their decision to the Inspector-General of Agriculture to the effect that they do not think it advisable to ask the Secretary of State for any further relaxation of the rules, but it is under consideration to authorize the Inspector-General of Agriculture to correspond and communicate direct by telegram with Director General of Stores, India Office.

F. G. SLY,

Offg. Inspector-General of Agriculture in India and President, Board of Agriculture in India.

RULES OF THE [illegible] LIBRARY.

(a) *General.*

1. The Library will be open during the working hours of [illegible] and at such other times as the Director may prescribe.

2. The persons entitled to use the Reading Room are the gazetted officers, upper subordinate staff and students of the Institute. Other persons may be permitted to use it with the special sanction of the Director or the officer in charge.

3. No one shall remove from the Library or Reading Room any book or other object belonging to it except in accordance with rules 9 to 14, regulating the issue of books on loan.

4. Books shall not be replaced in the cases, but shall be left on the special table provided for the purpose.

5. No one shall, whether under pretence of correcting an error or otherwise, make any mark on any book, nor turn down its leaves, nor otherwise damage it.

6. Tracing is forbidden except when special permission has been obtained.

7. All umbrellas, sticks, parcels and the like shall be left at the place provided for their custody.

8. No conversation shall be allowed in the Reading Room.

(b) Rules for the issue of books on loan.

9. Gazetted officers of the Pusa Institute are permitted to take books on loan from the Library on giving written receipt, but no book must be taken away from Pusa without the special permission of the Director or officer in charge of the Library.

NOTE.—Books required for constant reference in the offices of the Pusa staff will be kept in the separate sectional Library of each officer. These are shown by letters in the general catalogue as follows:—D=Director C=Agricultural Chemist, M=Mycologist, E=Entomologist, A=Agriculturist, B=Botanist, AB=Agri-bacteriologist. They are not available for loan, except with the special permission of the officer concerned.

10. Gazetted officers of the Provincial Departments of Agriculture will be supplied with books on loan from the Library (excluding those kept in sectional Libraries—see note to preceding rule) on the receipt of a written request by the Librarian. Whether a book can be lent or not will be decided by the Director or the officer in charge.

11. Books taken out on loan are liable to recall at any time, but if not so recalled, they may be kept for a space of one month, which period may be extended by the officer in charge at his discretion.

12. If a book is lost by the borrower, he must pay the cost incurred in its replacement.

13. The cost of postage or carriage from the Library to the borrower will be paid by the Library, but that from the borrower to the Library must be paid by the borrower.

14. The number of volumes which may be taken out on loan at one time is ordinarily limited to six.